Odour Component Study

Volume 2 ii

Qualitative Odour Risk Assessment and Mitigation Planning Report Cavendish Beef Farm (EIS Registration 2002)

Prepared for:

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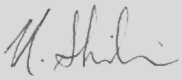
Senior Environmental Engineer	Nick Shinbin		12 Aug 2021

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1.0 INTRODUCTION

Independent Environmental Consultants (IEC) was retained by Viking Fur Inc. (Viking) to complete an assessment of potential odour risks from their mink and proposed cattle farm located in Cavendish, Newfoundland and Labrador (the Facility). Viking has operated the Facility as a mink fur farm since 2004 and is proposing to introduce cattle farming to diversify its business. As an undertaking that is subject to the Newfoundland and Labrador *Environmental Protection Act*, the proposed cattle operation was registered with the Department of Municipal Affairs and Environment (DoMAE) in February 2019. In April 2019, the Minister of the DoMAE informed Viking Fur that an Environmental Impact Statement (EIS) was required to determine if the proposal may have significant environmental or social impacts, including on odour. The final EIS Guidelines were issued for the undertaking in November 2019, which included a requirement to evaluate the current and potential future impacts of Viking's proposed beef cattle operation with respect to odour. The proposed cattle operation includes adding 100 head of cattle (and subsequent offspring) and acquiring and developing agricultural land for pasture grazing and forage production.

This assessment evaluates potential odour risks originating from Viking's current and future farming operations with respect to residents and communities in proximity to the farm. The potential odour effects were assessed using a qualitative risk assessment approach that was based on an analysis of odour generating activities at the farm, current mitigative measures, historical odour complaints and an odour survey completed by local stakeholders, local meteorological and topographical features of the area and the sensitivity of receptors and potential loss of amenity.

Using the above data, a qualitative analysis of potential odour risks on local residents was completed by ranking the magnitude of the odour source potential, the effectiveness of the source-receptor pathway with respect to odour dispersal, and the sensitivity of the community to odours. Based on the results of the odour risk assessment, a series of supplemental odour management options were prepared and a framework for an Odour Management and Control Plan (OMCP) was developed.

2.0 PROJECT DESCRIPTION

The Facility was originally established as a fur farm in the late 1970s. Viking has owned and operated the Facility as a mink fur farm since 2004. The farm is situated near Cavendish, Newfoundland and Labrador in Trinity Bay and is currently permitted to house 15,000 breeding female mink (100 animal units [AU]) under Certificate of Approval (CofA) A-WMS11-024-2010F, issued by the Newfoundland and Labrador DoMAE in April 2020. The Facility consists of 22 mink sheds, feed plant, cold storage facility, pelting shed, shavings shed, compost facility, manure separator, two liquid manure tanks, and a septic field. Figure 2-1 provides an overview of the Viking Fur farming operations, current and proposed pasture/forage lands, and other local pasture and forage lands not belonging to Viking.

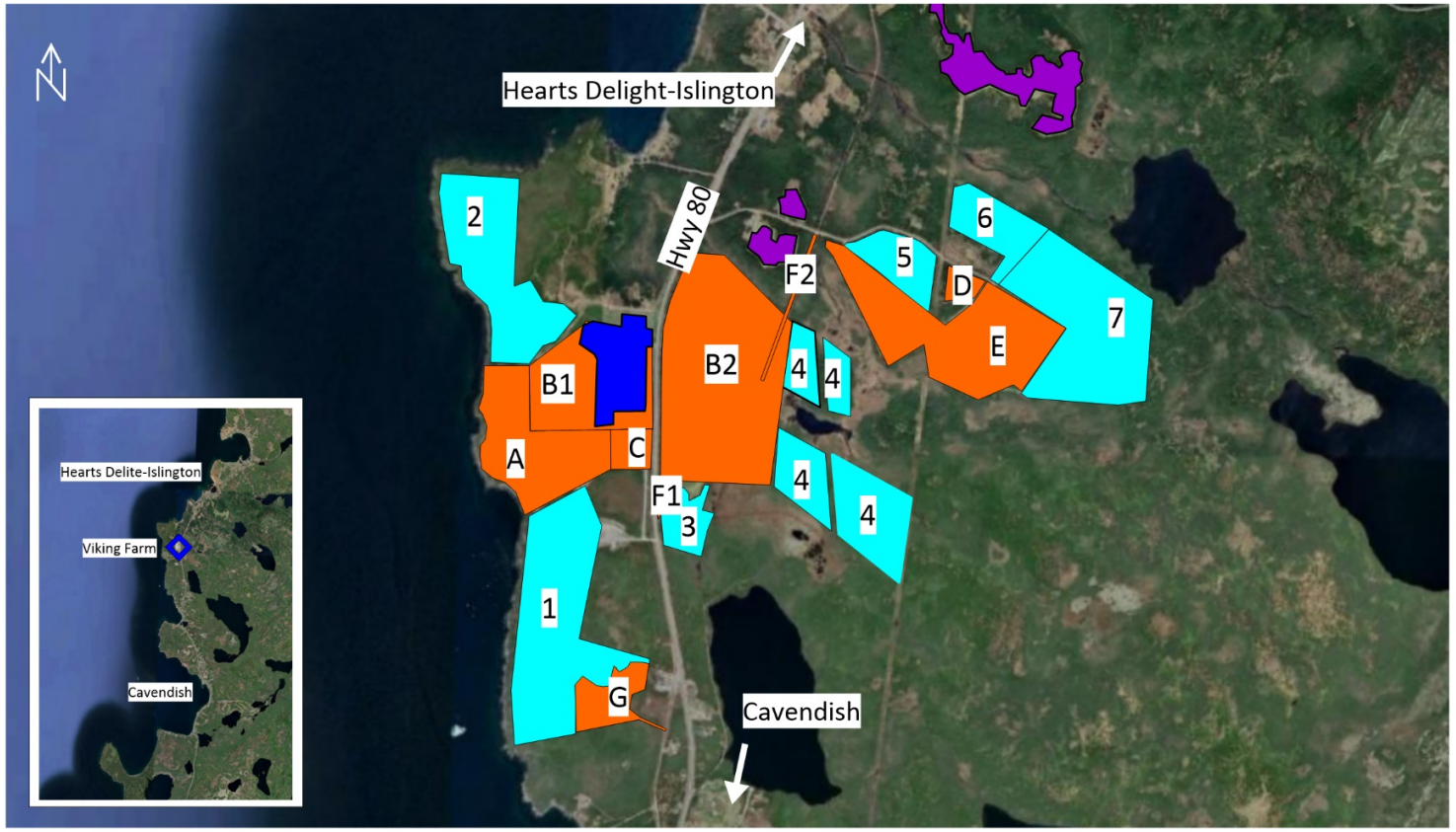
The proposed cattle operation will complement the existing mink operations with an initial herd size of 26 and an eventual expansion to 100 grass-fed Galloway cattle. The current Viking farm consists of approximately 278 acres of leased agricultural land, of which approximately 106 acres is cleared and in production as pasture and forage land. Viking has also applied to lease approximately 290 acres of additional lands. Approximately 200

acres of this land would be developed for pasture and forage production. In addition to Viking's own pasture and forage land, liquid mink manure is spread on other local fields near Viking's farm. These fields are denoted as Other Farms in Figure 2-1 and collectively cover approximately 51 acres.

In addition to the allowed 15,000 breeding female mink, the CofA also permits the operation of a manure waste management system and contains terms and conditions that Viking must adhere to, including provisions related to odour management procedures. These provisions pertain to the following:

- storage, removal, and spreading of manure;
- carcass disposal;
- other waste management (i.e., feed/feedstock, composting);
- monitoring programs; and
- incident reporting (i.e., spills, leaks, complaints)

Viking also holds a Fur Farm Operation License (19-003) issued under the *Animal Health and Protection Act* of Newfoundland and Labrador, on November 28, 2019. This license permits Viking to operate a mink fur farm and governs animal euthanasia and escapes under Newfoundland and Labrador Regulation 38/12 *Fur Farming Regulations* under the *Animal Health and Protection Act*. The license is conditional on abiding by the provisions for mink outlined in Newfoundland and Labrador Regulation 36/12 *Animal Protection Standards Regulations* under the *Animal Health and Protection Act* and Regulation 52/15 *Animal Protection Standards Regulations* under the *Animal Health and Protection Act,* which relate to the *Code of Practice for the Care and Handling of Farmed Mink* (2013) published by the National Farm Animal Care Council [1].



LEGEND:

- Viking Farm
- Current Viking Pasture/Forage Lands
- Proposed Lease Pasture/Forage Lands
- Other Pasture Lands

NOTES:

SCALE:

m (Bottom Drawing Only)

300 600

REFERENCE:

UTM Zone 22, WGS84

Viking Fur

Site Layout and Location Plan

Drawn By:	Approved By:	Figure No.:
PLK	NS	2-1
Date:	Project No.:	
August 2021	SX20-0003	

3.0 ODOUR PRIMER

Odour is caused by a single chemical compound or mixture of compounds that, depending on the concentration, triggers the sense of smell in human nasal cavity (olfactory nerve) and is interpreted in the brain as an odour. Odours from livestock farms are related to the emission of several hundred different substances (odorants) into the air, especially carboxylic acids, sulphur-containing compounds, phenols, aldehydes, ammonia, and others [2] [3].

Humans can detect some chemical concentrations as low as a few parts per billion (ppb), or less in air [4]. Human perception of odorant mixtures, such as those in livestock odour, can be very different from responses to individual chemicals. Odorants can act as additive and masking agents (whereby one quality is enhanced/suppressed, totally or partially, by the other), counteractants (whereby one quality is neutralized or minimized by the other) and can also be synergistic (whereby one quality is enhanced by the other). These factors make odour quantification and characterization a challenging process.

Human responses to odours generally follow a number of characteristic patterns associated with sensory functions. In the general population, odour perception typically follows a normal distribution with 96% of people having a “normal” sense of smell while 4% either have an acute sense or a reduced sense of smell [5]. While sensitivity is normally distributed amongst the general population, it is not constant across odorants or individuals, leading to a wide variation in conditions that can lead to odour complaints.

Odours may be perceived as pleasant or unpleasant. However, the main concern with odour is its ability to cause a response in individuals that is considered to be objectionable or offensive.

4.0 STUDY METHODOLOGY

The potential effects of the Viking’s operations were assessed using a qualitative risk assessment approach that was based on information on the farm operations, the surrounding area and the community, including:

- Farm operating practices and procedures;
- Farm odour control and management measures;
- Community-based odour survey data;
- Locations of sensitive receptors (residential and tourism);
- Historical odour complaints;
- Historical meteorology

Predictive modelling and on-site odour (olfactory) monitoring were not completed as part of the scope of work given the uncertainties that each method presented, the overall complexities of each approach, resource requirements and complications due to the COVID-19 pandemic. In summary:

- Modelling: difficulties accessing site/defining model source terms in light of COVID-19 pandemic, inability of models to relate changing nature of odour emissions at the farm and in the community (combinations of odorants; variability in odour emission rates; dynamic changes in meteorology),

inability to relate odour intensity, hedonic tone and overall community sensitivity, unable to relate other sources of odour (non-Viking) that may be contributing to concerns.
- Monitoring: need for trained/calibrated local observers, difficulty aligning sampling times with periods of odour generation and complaints (non-continuous method), inability to remove other background sources of odour from samples, resource heavy and costly, difficulties implementing program in light of COVID-19 pandemic.

Most importantly, the current method was selected as it employs a community-based engagement and survey approach that focused on understanding odour effects through a dose-response relationship.

4.1 BASIS OF THE QUALITATIVE RISK ASSESSMENT

A qualitative risk-based approach, based on Source-Pathway-Receptor (S-P-R) relationship, was employed to evaluate the potential for adverse odour effects on the local community. For an adverse effect to occur at a receptor, there must be an odour exposure at that receptor, which requires consideration to the three elements of the S-P-R chain:

- an emission **SOURCE** – presence of odourous compound(s) and a means of release to the atmosphere;
- a **PATHWAY** – for the odour to travel through the air to off-site receptors, recognizing that:
    - anything that increases dilution and dispersion of an odorous contaminant plume as it travels from source to receptor will reduce the concentration at the receptor, and thereby reduce exposure; and
    - increasing the length of the pathway can increase the dilution and dispersion.
- the presence of **RECEPTORS** (i.e., residential dwellings or commercial tourism lodgings) that could experience an adverse effect, acknowledging that people vary in their sensitivity response to various odours.

The scale or impact of exposure is determined by the parameters collectively known as the FIDOL factors (Frequency, Intensity, Duration, Offensiveness and Location). The magnitude of the effect experienced by individuals is determined by the degree of exposure to the FIDOL factors, with the Location (L) factor accounting not only for the physical location of the receptor, but also its sensitivity, including the social and psychological factors that can be expected for a given community and whether there is a potential loss in amenity. Table 4-1 provides a summary of the FIDOL factors.

Table 4-1: Summary of FIDOL Factors

Descriptor		Explanation
F	Frequency	How often an individual is exposed to odour.
I	Intensity	The individual's perception of the strength of the odour.
D	Duration	The overall duration that individuals are exposed to an odour over time.
O	Odour Unpleasantness	The character of an odour as it relates to the hedonic tone [1] at a given odour concentration/intensity.
L	Receptor Sensitivity	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor (i.e., sensitivity).

NOTES:
[1] Hedonic tone scale: +4 very pleasant; +3 pleasant; +2 moderately pleasant; +1 mildly pleasant; 0 neutral odour / no odour; -1 mildly unpleasant; -2 moderately unpleasant; -3 unpleasant; -4 offensive.

Qualitative risk-based odour assessments are founded on the principle that overall risk of an odour exposure occurring is dependent on the *probability* of an exposure occurring at a given location and the *consequence* of the effect resulting from the exposure. For odour assessments, the *probability* is defined by the likelihood of exposure, and the *consequence* can be considered to be the effect on the receptor if that exposure (impact) took place (e.g., loss of amenity). These two elements are reflected in the S-P-R assessment concept. It should be noted that while qualitative risk-based odour assessments consider at the probability (i.e., the likelihood or chance) of an impact occurring at a location and the likely magnitude of the effect resulting from that exposure, they do not predict with certainty that any given impact/exposure will occur at a particular time.

The risk of an adverse effect occurring from that exposure is effectively described using a dose-response relationship, whereby the magnitude of the effect is determined by the relative magnitudes of the dose and response. The dose can be considered equivalent to the odour exposure, or the impact as determined by the FIDO factors in Table 4-1. The response is then ranked depending on the receptor sensitivity (i.e., responsiveness to odour), which is characterized by the L factor in Table 4-1. The risk of an adverse effect is then determined based on the interplay between the severity of the exposure (dose) and sensitivity of receptor (response). The ranking mechanisms for risk of odour exposure and risk of adverse effect due to odour are discussed further in the following section.

4.1.1 Assessment Approach

The relative accuracy of a qualitative risk assessment to predict impacts is largely dependent on the accuracy of the ranking of the magnitude of the source release, the effectiveness of the pathway, and the sensitivity of the receptor. The detailed ranking criteria applied in this assessment are provided in Table 4-4, and are discussed

generally below. The first step in the risk assessment is to estimate the **Source Odour Potential** of the site activities, which consider the following key factors:

- the magnitude of the odour release with consideration to odour-control measures;
- how inherently odorous the compounds are; and
- the unpleasantness of the odour (hedonic tone).

Using the information in Table 4-4, the Source Odour Potential is ranked as being Low, Moderate, or High. Following the determination of Source Odour Potential, the **Pathway Effectiveness** to the receptor is assessed with consideration to the following:

- distance from source to receptor the frequency (%) of winds from the source to receptor;
- the effectiveness of any mitigation/control in reducing flux to the receptor;
- the effectiveness of dispersion/dilution in reducing the odour flux to the receptor; and
- topography.

Using the information in Table 4-4, the Pathway Effectiveness is ranked as being Ineffective, Moderately Effective, or Highly Effective.

These estimates of Source Odour Potential and the Pathway Effectiveness are then considered together to predict the **Risk of Odour Exposure** at a given receptor location/group (see Table 4-2). The risk of odour exposure is characterized as *Negligible Risk, Low Risk, Medium Risk, or High Risk*.

Table 4-2: Risk of Odour Exposure (Source Odour Potential and Pathway Effectiveness)

Pathway Effectiveness	Source Odour Potential		
	Low	Moderate	High
Ineffective	Low Risk	Medium Risk	High Risk
Moderately Effective	Negligible Risk	Low Risk	Medium Risk
Highly Effective	Negligible Risk	Negligible Risk	Low Risk

The final step is to estimate the effect of that odour exposure on the receptor, with consideration to the **Receptor Sensitivity**, which is assessed per Table 4-4, using the following:

- user expectations on enjoyment of an amenity; and
- the duration and frequency of exposure of individuals at the amenity as part of the normal pattern of use.

On the basis of the above factors, the **Risk of Odour Effect** is then characterised as either: *Negligible, Slightly Adverse, Moderately Adverse, or Substantially Adverse* (see Table 4-3). For development projects, the overall odour effect is likely to be considered significant if it is *Moderately Adverse* or *Substantially Adverse*, while for *Slightly Adverse* or *Negligible* effects, the impact may be deemed acceptable or tolerable.

Table 4-3: Risk of Odour Effect (Receptor Sensitivity)

Risk of Odour Exposure	Receptor Sensitivity		
	Low	Medium	High
High Risk	Slightly Adverse	Moderate Adverse	Substantial Adverse
Medium Risk	Negligible	Slightly Adverse	Moderately Adverse
Low Risk	Negligible	Negligible	Slightly Adverse
Negligible Risk	Negligible	Negligible	Negligible

4.1.2 Receptors

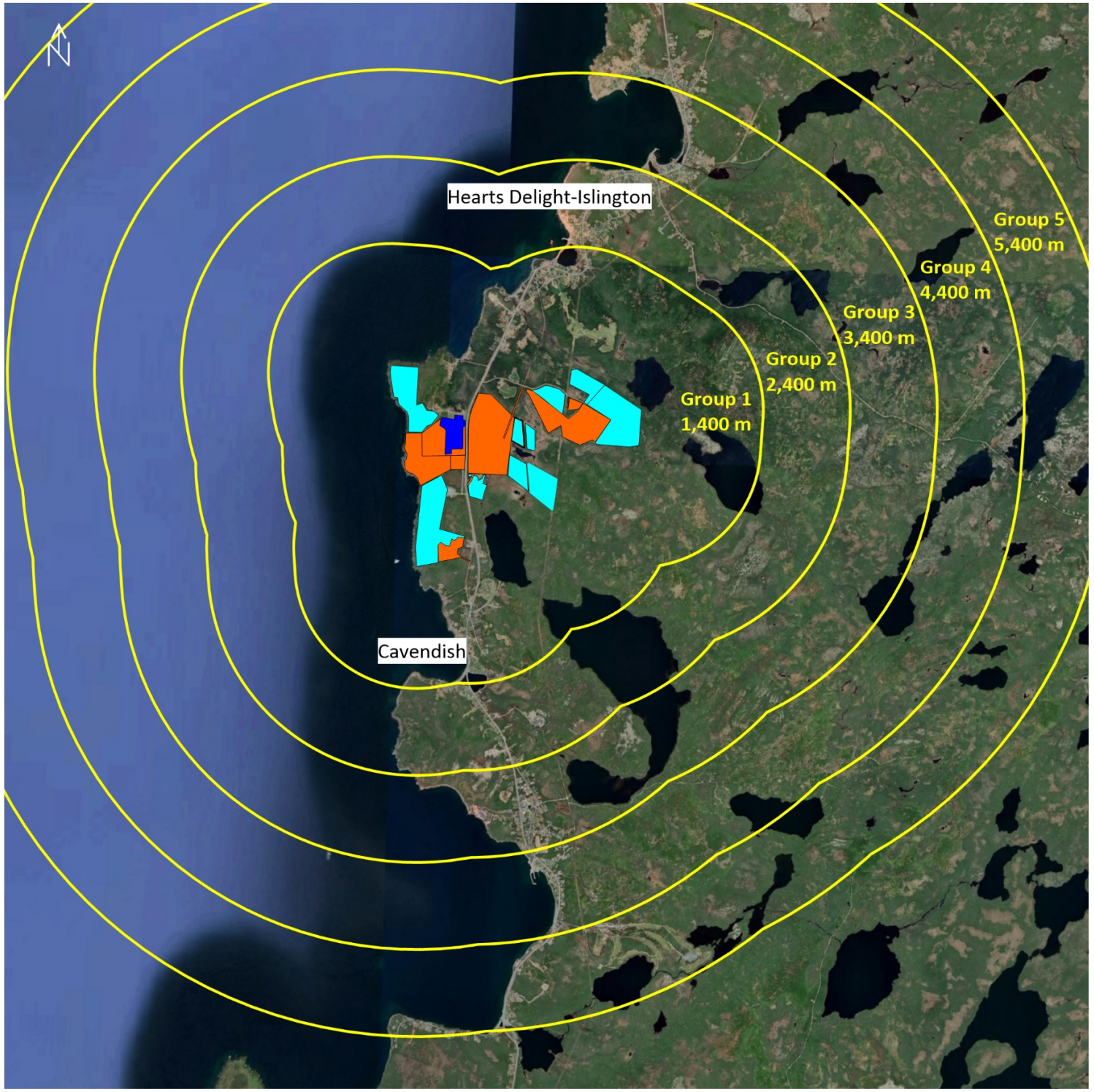
For ease of assessment, community receptors have been grouped into five (5) categories based on their distance from the existing mink farm, existing manure spreading and future planned activities relating to cattle production, including the proposed lease of additional pasture and forage areas. Note that the initial Receptor Group 1 distance is based on a conservative determination of minimum separation distances[1] required for mink farms as outlined in the *Environmental Guidelines for Livestock Producers in Newfoundland and Labrador* [5], while the remaining groupings are at +1,000 meter increments from this initial distance. Figure 4-1 provides an illustration of the receptor groupings.

[1] The MSD is calculated based on formula established in Table D.1 of the Environmental Guidelines for Livestock Producers in Newfoundland and Labrador for the "nearest neighbouring dwelling" and "residential, commercial or recreational areas" and the base distance determination as a function of the number of animal unit (AU) equivalents for mink and cattle. A series of adjustments are also allowed, which include expansion factors, manure system factors and livestock and housing type factors. The minimum separation distance calculated from the above guideline for mink ranges from 700 to 1,400 m (for >600 AU) and 300 to 600 meters for cattle (for <100 AU). For the purpose of establishing the source-pathway distance, the most conservative separation distance of 1,400 meter was employed (basis of Group 1 receptors).

Table 4-4: Risk Factors for Odour Source, Pathway and Receptor Sensitivity

Source Odour Potential (S)	Pathway Effectiveness (P)	Receptor Sensitivity (R)
High Source Odour Potential	**Ineffective Pathway**	**High Sensitivity Receptor**
Magnitude ▪ Larger permitted processes of odorous nature; ▪ Materials usage thousands of tonnes/m^3 per year. ▪ Area sources of thousands of m^2. ▪ Very odorous compounds (e.g., ammonia), having very low odour detection thresholds (ODTs). Unpleasantness ▪ Compounds/odours having unpleasant (-2) to very unpleasant (-4) hedonic score[1]. Mitigation/control ▪ Open air operation with no containment and high odour potential, ▪ Reliance solely on good management techniques and best practice.	Distance ▪ Receptor is adjacent or in close proximity to the source/site (<1,400 m); Direction ▪ High frequency (%) of winds from source to receptor (or, qualitatively, receptors downwind of source with respect to prevailing wind). ▪ Topography and terrain conditions that highly influence pathways Effectiveness of dispersion/dilution ▪ Open processes with low-level releases (e.g., open tanks/lagoons, composting of putrescible wastes)	User Enjoyment ▪ Users may experience a reduction in enjoyment of an amenity. Duration/Frequency ▪ People expected to be continuously present, or at least regularly for extended periods (>8 hours/day), as part of the normal pattern of use of their properties.
Moderate Source Odour Potential	**Moderately Effective Pathway**	**Medium Sensitivity Receptor**
Magnitude ▪ Medium size permitted processes; ▪ Materials usage hundreds of tonnes/m^3 per year; ▪ Area sources of hundreds of m^2. ▪ The compounds involved are moderately odorous. Unpleasantness ▪ Compounds/odours having neutral (0) to unpleasant (-2) hedonic score[1]. Mitigation/control ▪ Substantial mitigation measures in place, but significant residual odour potential remains.	Distance ▪ Receptor is local to the source (within 1,400 – 3,400 m). Direction ▪ Moderate frequency (%) of winds from source to receptor (or, qualitatively, receptors downwind of source with respect to prevailing wind). ▪ Topography and terrain conditions that moderately influence pathways Effectiveness of dispersion/dilution ▪ Mostly closed processes with elevated releases, but compromised by building effects	User Enjoyment ▪ Users would expect to enjoy a reasonable level of amenity Duration/Frequency ▪ People wouldn't reasonably be expected to be regularly present for extended periods (<8 hours/day) as part of the normal pattern of use of their properties.

Source Odour Potential (S)	Pathway Effectiveness (P)	Receptor Sensitivity (R)
Low Source Odour Potential	**Highly Effective Pathway**	**Low Sensitivity Receptor**
Magnitude ▪ Small size permitted processes; ▪ Materials usage tens of tonnes/m^3 per year; ▪ Area sources of tens m^2. ▪ The compounds involved are only mildly odorous, having relatively high ODTs where known. Unpleasantness ▪ Compounds/odours having neutral (0) to very pleasant (+4) hedonic score[1]. Mitigation/control ▪ Effective, tangible mitigation measures in place leading to little or no residual odour potential.	Distance ▪ Receptor is remote from the source (3,400 m +); Direction ▪ Low frequency (%) of winds from source to receptor (or, qualitatively, receptors upwind of source with respect to prevailing wind). ▪ Topography and terrain conditions that moderately influence pathways Effectiveness of dispersion/dilution ▪ Releases are from high elevations (e.g., tall stacks or roof vents) and are not compromised by surrounding buildings	User Enjoyment ▪ The loss of enjoyment of amenity would not reasonably be expected Duration/Frequency ▪ There is transient exposure, where the people would reasonably be expected to be present only for limited periods of time (<1-2 hour/day) as part of the normal pattern of use of the land.
NOTES: [1] Hedonic tone scale: +4 very pleasant; +3 pleasant; +2 moderately pleasant; +1 mildly pleasant; 0 neutral odour / no odour; -1 mildly unpleasant; -2 moderately unpleasant; -3 unpleasant; -4 offensive.		



LEGEND:

- Viking Mink Farm
- Current Pasture/Forage Lands
- Proposed Lease Pasture/Forage Lands
- Receptor Groupings (1-5)

NOTES:

SCALE:

1000 2000 m

REFERENCE:

UTM Zone 22T, WGS84

Viking Fur

Receptor Grouping

Drawn By:	Approved By:	Figure No.:
PLK	NS	4-1
Date:	Project No.:	
August 2021	SX20-0003	

5.0 QUALITATIVE ODOUR RISK ASSESSMENT

The qualitative odour risk assessment is presented in the following sections and includes a summary of the available data that serves as the basis for establishing the potential risk level associated with the source odour potential, pathway effectiveness, and receptor sensitivity.

5.1 SOURCE ODOUR POTENTIAL

5.1.1 Mink Odour Characteristics

Mink fur farms can be a source of odourous emissions and complaints. Odours can be formed during the fermentation process where litter, urine, excrement, and food remains decompose, and can also form during respiration, digestion, and evaporation from animal skin [2]. Animal feces naturally contains elevated concentrations of ammonia, nitrous oxide, and volatile organic compounds, and emissions can vary with environmental conditions (e.g., aerobic/anaerobic/anoxic conditions, temperature, humidity, wind speed/direction) [6] [7]. The decomposition of organic components produces methane, carbon dioxide, and trace amounts of compounds such as hydrogen sulphide, mercaptans, and non-methane organics. The sulphur-containing compounds can cause offensive smells (low odour detection threshold), such as a rotten egg smell (hydrogen sulphide) or rotten cabbage smell (mercaptans). These odours can register unpleasant (-2) to very unpleasant (-4) hedonic tones and generate complaints/annoyance within communities.

5.1.2 Odour Sources and Controls

5.1.2.1 Mink Farm Operations

Viking produces 6,600 m^3 of liquid and solid manure waste (5,610 m^3 of liquid (or 85% of total) and 990 m^3 of solid (or 15% of total) waste) annually. Manure production varies seasonally throughout the mink lifecycle. The lowest manure production occurs between January and April (about 9% of annual manure production) after pelting the mink in November and December, while the highest manure production occurs between July and October (about 91% of annual manure production). All manure and associated wastes are stored in an approved manure storage facility. Viking's manure management system includes automated cleaning and backflushing of a gutter waste collection system in the mink barns. Manure/waste is collected and removed within 1-3 days, depending on density of the mink per pen. The waste is transported through a settling tank and a SWEA separator where solids are removed from the waste stream and are composted. The liquid waste is pumped from the settling tank into two open-top holding tanks equipped with a Center Agitation System. There is the potential for odour to be generated throughout all stages of this system.

Annually, Viking pelts approximately 130,000 mink from their facility and from two other fur farms in the province. A mink carcass weighs about 1 kg, as a result, approximately 130,000 kg of mink carcasses are produced annually from pelting, the majority between November to December and into the early Spring. During pelting, mink carcasses are transported daily to Viking's compost shed. A further 4,000 kg of mink carcasses are generated annually from mortalities. Under Viking's carcass disposal plan, all mink carcasses are composted on site. Carcasses are stored in the onsite composting containment building until early January when compost piles are created. Compost piles (windrows) are constructed on the concrete floor as a series of layers alternating between a carbon source, such as used bedding, sawdust, or forage, and the carcasses. The

surface of each compost pile is capped with 60 cm of a carbon substrate (i.e., wood chafe, hay and/or used bedding). Compost piles are turned periodically while checking temperature and moisture levels until May when the composting process is completed. Male minks are pelted in March and a new compost pile is created following the same procedure followed for the pelting in November and December. There is potential for odour to be generated from pelting and composting of mink carcasses.

There is also potential odour from the mink feed materials. Mink feed consists of a mixture of chicken by-product and/or fish offal (varies throughout the year), vitamins, minerals, and grains. Young minks (kits) are fed twice daily from early June to November and adults are fed daily. Mink feed is mixed in the feed kitchen and transported in the barns on open carts. Viking receives approximately 21 tonnes of processed chicken per day (249 days per year). Viking also accepts chicken by-products twice daily, five days per week, except on Fridays. Upon receipt, Viking ensures all chicken by-product is frozen by placing the by-product into plastic containers for freezing in their cold storage unit. Viking also receives spent hens from egg producing farms. If Viking's capacity to store chicken reaches 90%, no more chicken is accepted. However, this condition is highly unlikely given the current freezing capacity and the amount of chicken byproducts available to Viking. All feathers received from the chicken waste are compressed and sent to landfill within 24 hours. If there is a significant amount of chicken that are deemed unsuitable for creation of mink feed (e.g., contaminated), the waste material is transferred to a landfill. Fish offal is periodically accepted or a more sporadic basis throughout the year, with the most continuous supply occurring in the early summer. All fish is frozen upon receipt.

To minimize farm odours, Viking Fur has developed and employs multiple protocols to minimize potential odour sources. All receiving and processing areas are washed down daily and disinfected twice a week, all chicken/fish vats/pans are cleaned immediately after the material is removed, all containers used to store and transport feed are securely covered at all times, and all wastewater from the wash down area passes through a filter which removes materials greater than 0.5 cm; larger materials are transferred to the compost dome weekly and the remaining liquid and wastes flow to the septic system. Additional details on existing controls are provided in Table 5-1.

Table 5-1: Existing Mink Farm Odour Controls

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)
		Current
Mink barns and liquid/solid manure separator	Mink rearing/feeding barns	▪ Passive ventilation ▪ Approved manure management plan and liquid and solids waste management system (gutter system, backwash) ▪ Regular changing of bedding ▪ Cleaning and disinfection protocols ▪ Prompt removal of mortalities ▪ Composting of manure solids and collection of liquids in storage tanks

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)
		Current
Manure storage tanks	Open top tanks for the storage of liquid manure	▪ Large storage capacity to control farm wide liquid manure year-round ▪ Emergency shut-off valves and safety mechanisms to control accidental releases ▪ Center agitation system
Feed Kitchen / Storage / Distribution	Preparation and storage of mink feed (chicken and fish offal)	▪ Receiving, testing, preserving, and cold storage of feed stock ▪ All mink feedstock delivered to site must be in sealed/leak proof containers or in vehicle where tarpaulin/other covering is attached ▪ Feed covered when not in use and disposed of in a timely manner ▪ Feed cooled or frozen within 24 hours of receipt ▪ When freezer storage >90%, no further feed is accepted until space is available ▪ Feathers covered/contained, no more than 1 truck load of feathers on site at any time, disposed of at approved waste facility ▪ Feed kitchen washed down daily and disinfected weekly, all fish vats/pans cleaned immediately after product is taken out ▪ All wastewater from wash down area is disposed of through septic system
Carcass Composting	Windrows composting of carcasses	▪ Formal carcass disposal plan ▪ Covered with a roof ▪ Impermeable concrete floor ▪ Windrow temperature and moisture are monitored and recorded on file daily ▪ Only solids from manure system and carcasses are composted ▪ Monitoring and record keeping (temperature, moisture content)
Other Waste and Wastewater Management	Waste other than manure and carcasses and wastewater	▪ Waste generated collected in refuse containers and disposed of on weekly basis at an approved site ▪ Wastewater deposited in septic field after separator removes solid matter for composting ▪ Farm drainage system prevent standing water build-up

5.1.2.2 Manure Spreading

Stored liquid manure is applied to pasture and forage lands on or around Viking's facility two (2) or three (3) times a year. Other farms in proximity to Viking Fur allow for the spreading of liquid manure on their lands under existing agreements [8]. Viking spreads liquid manure on 130 acres for a total of approximately 4,335 tonnes of manure, all of which are Viking's own fields except for approximately 30 acres. Fully composted solid manure is added to pasture / forage fields as a soil amendment to supplement topsoil.

Before Viking commissioned their liquid manure management system, Viking spread solid manure on forage lands, which reportedly generated odour complaints from the local community. Presently, Viking only spreads liquid manure on pasture / forage lands. Liquid mink manure is known to have high concentrations of odourous compounds (and result in more annoying odours) as compared to drier manure [9] [10]. Moreover, odour potential increases as temperature and humidity increase and with elevated wind speeds [11] [9].

From an odour mitigation/control perspective, Viking is required to follow the terms and conditions of their CofA and the *Protocol for Viking Fur Manure Spreading* as developed by the Department of Fisheries and Land Resources that includes:

- Spillage of manure from vehicles during transport is strictly prohibited;
- Using local weather forecasts (wind direction) to determine optimal time/date for spreading;
- Providing notification(s) to the Town of Heart's Delight-Islington 48-hours in advance of spreading;
- Limiting application to Viking lands to two to three times per year during the Spring (late May), Summer (mid-late August), and Fall (mid-late October); and
- Limiting application to other farmlands to two times per year during the Spring (late May) and Fall (mid-late October).

Viking also employs the use of low-profile spray nozzle manifolds to distribute the liquid manure across larger surface areas and reduces odour formation. While the spreading of manure can generate odour complaints, the number of applications per year remains very low (2 to 3 times per year) and occurs over a few days, which tends to mitigate the overall odour impact.

5.1.2.3 Cattle

The most objectionable odours from cattle pasturing are the result of volatile compounds generated during the decomposition of manure. Commonly reported odorous compounds associated with manure are those containing sulfur (e.g., hydrogen sulfide and mercaptans), nitrogen (e.g., ammonia and amines), volatile organic acids, phenols and alcohols [12].

The potential for odour from cattle production at the farm is generally mitigated by the low densities of animals within the pastureland areas and the high degree of manure dispersal within these areas (i.e., promoting natural fertilization of fields). Further, Viking has reported that cattle would be pastured throughout the year and there would be no need for a constructed area to manage/store cattle manure.

5.2 PATHWAY EFFECTIVENESS

5.2.1 Pathway Length

The measured distance from the nearest residential or commercial dwellings to Viking mink farm and pasture and forage lands are presented in Table 5-2 (Refer to Figure 2-1 for a description of the lease areas). While the distances noted below are conservatively estimated from the closest point along Viking Fur's facility/pasture and forage lands to the nearest sensitive receptor, they all fall within the Group 1 receptor distance (1,400 meters) and would be expected to have a higher risk of odour exposure.

Table 5-2: Viking Fur-Local Receptor Separation Distance

ID	Areas of Interest	Approximate Distance (m) to Nearest Receptors [1]	Direction of Receptor Relative to Field
B1	Viking Fur Farm and Existing Field B1	540	N
A	Existing Field A	790	N
B2	Existing Field B2 [2]	390	NW
C	Existing Field C	970	S
D	Existing Field D	950	NW
E	Existing Field E	530	NW
G	Existing Field G	150	E
1	Proposed Field 1 (Pasture)	250	SE
2	Proposed Field 2 (Pasture)	320	E
3	Proposed Field 3 (Forage)	590	S
4	Proposed Field 4 (Forage) [3]	880	NE
5	Proposed Field 5 (Forage)	590	NW
6	Proposed Field 6 (Forage)	810	NW
7	Proposed Field 7 (Forage)	1,150	NW

NOTE:
[1] Distances are conservatively measured from the closest point along Viking Fur's facility/pasture and forage lands to the nearest sensitive receptor (rounded to the nearest 10 meters)
[2] Leases F1 and F2 are not considered above as they are merely permitted access to Lease B2 (see Figure 2-1)
[3] Proposed Field 4 consists of four lease blocks. Distance measurements were taken from the block that was closest to the sensitive receptors.

5.2.2 Wind Direction and Wind Speed

As odours from Viking farming operations are emitted, they move with the prevailing wind direction, and are diluted through dispersion. As the odour plume disperses, it spreads vertically and horizontally, sometimes with erratic and agitated motion, due to mechanical and thermal turbulence in the atmosphere. Mechanical turbulence requires wind and is caused when the speed or direction of the wind changes within a short vertical or horizontal distance. Mechanical turbulence can also result from friction of the wind with surface features (e.g., ground, buildings and trees). Thermal turbulence occurs with sunny to partly cloudy skies and light to moderate winds. With both mechanical and thermal turbulence, outside air is mixed with the plume and causes it to expand vertically and horizontally.

It is important to note that there were no meteorological stations located in the Cavendish area. The closest meteorological station is located in St. John's, Newfoundland and Labrador (approximately 60 km from Cavendish) and is not representative of the farm location. As a result, modelled data was used for this analysis. Hourly historical meteorological patterns were obtained from a Department of Environment, Climate Change and Municipalities approved Weather Research and Forecast (WRF) Non-Hydrostatic Mesoscale Model (WRF-NMM) for Cavendish and covered the period between 2017 and 2018.

Figure 5-1 shows that the dominant annualized wind directions are blowing from the south-west, west-south-west, and south-south-west (i.e., from the Viking farm towards the local community). Winds are expected to blow from these directions approximately 41% of the time. Seasonal distribution of wind direction and speed is shown in Figure 5-2 and Figure 5-3. Of note, the dominant wind direction during the summer months, where the majority of historical complaints are received, blow from the south-west, west-south-west, and south-south-west approximately 59% of the time. On this basis, it is likely that winds will be blowing towards sensitive receptors during regular summer farm operations, including during manure spreading operations. Very calm periods where wind speeds are less than 0.5 m/s (and therefore significant odour dilution is not expected) are anticipated for only 0.25% of the time.

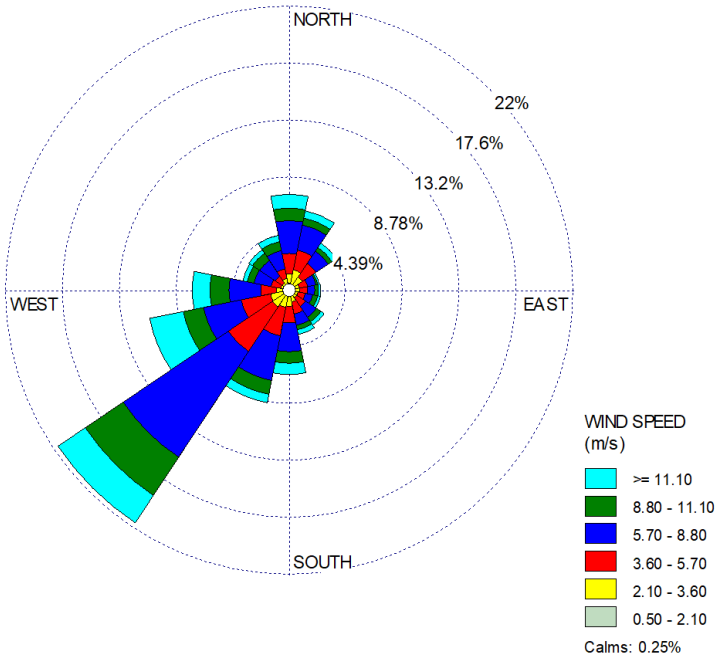


Figure 5-1: Wind Rose (2017-2018)

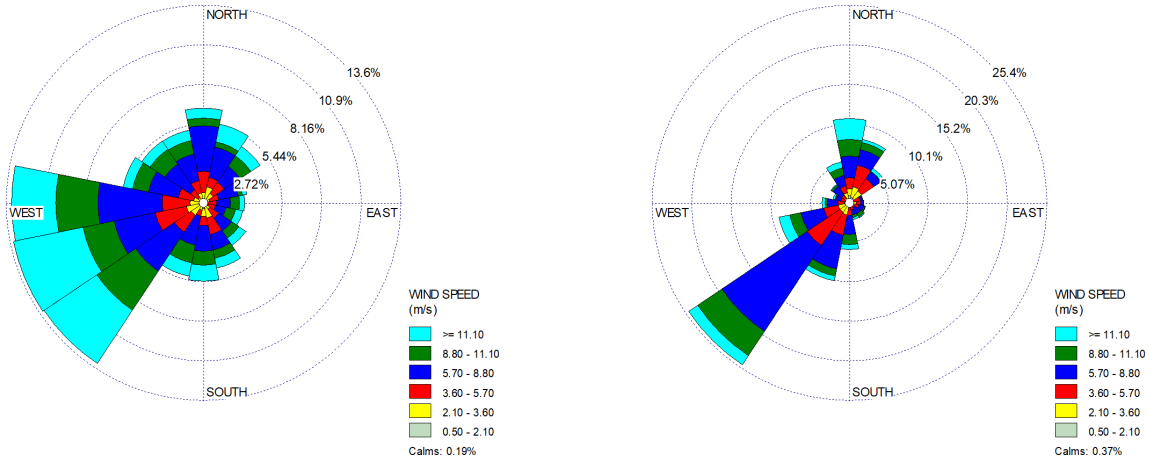


Figure 5-2: Wind Rose for Winter (December 1 - February 28) and Spring (March 1- May 31)

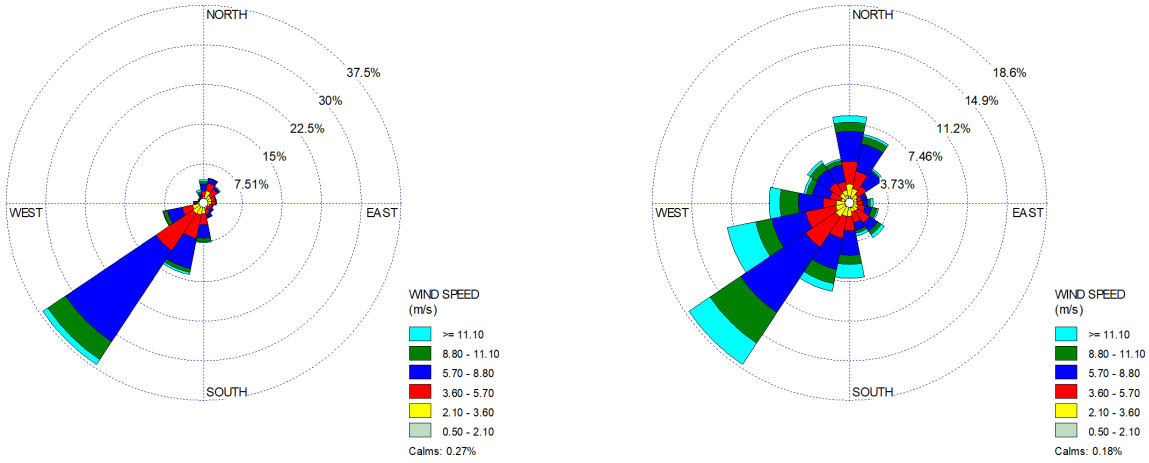


Figure 5-3: Wind Rose for Summer (June 1 - August 31) and Fall (September 1 - November 30)

5.2.3 Odour Dispersion

Odours from the farm operations are dispersed and diluted when outside air mixes with the odour plume. Atmospheric dispersion increases with increasing amounts of turbulence. Under good dispersion conditions, odours can be effectively diluted along the source-receptor pathway; however, under poor dispersion conditions, odour plumes are not dispersed effectively and can be detected downwind from the source (sometimes many kilometers away). Further, fugitive sources, like the manure storage tanks tend to release more odour (ammonia) during warmer temperatures and when winds agitate the surface of the tanks and disrupt naturally forming films on the surface [12].

Regardless of the dispersion conditions, odour intensity generally decreases as the plume moves farther away from the source of the odours. In the case of good dispersion, this decrease in odour intensity is rapid, but in the case of poor dispersion it is very slow. To assess the degree of odour dispersion in the community, an analysis of historical odour complaints received by Service NL (2014 to 2021) was completed and a community-based odour survey (August/September 2020) was developed and implemented.

Available historical odour complaints related to Viking Fur's operations provided by Service NL are detailed in Table 5-3 and date back to March 2014 [13]. Most of the historical odour complaints have originated outside of the winter months when temperatures and humidity were elevated and generally related to specific Farm operating conditions at the time. Service NL reported that they had not received any formal odour complaints concerning the farm since 2018 [14]. However, there remain community concerns about odour exposure from the farm operations and manure spreading, which were communicated during open houses held in May 2021.

Concerns identified during historical Service NL inspections or as part of investigations into local community complaints related to the presence of standing water, housekeeping issues, and the presence of flies and odours. With regard to the latter, some odour concerns were related to a one-time delivery of poor quality Caplin feedstock. There was insufficient information provided in the Service NL correspondence to allow for a more detailed analysis of the odour pathway, since the type, strength/intensity, persistence and location of the complainants was not provided.

Table 5-3: Key Historical Odour Complaints and Inspections

Date [1]	Reason/ Source	Complaint Claims	Result
Mar. 14, 2014	Scheduled Site Inspection	Not applicable	"Bin Style" manure system in operation. One composting row in tarped pad area. Good site conditions, very little standing water on site. Drainage system installed between barns to prevent standing water.
Apr. 24, 2014	Update on Viking Fur provided by Service NL on behalf of Viking Fur to CLC concerns	Not applicable	Construction underway for enclosed composting and wood shavings buildings. Drainage systems completed between barns to ensure farm stays as dry as possible. New liquid manure system under construction (incl. two tanks and under barn conveyance system). Land is being cleared for liquid manure spreading on land acquired through the approval process. Land may take several months to a couple years of preparation for hay production.
Jan. 29, 2015	Scheduled Site Inspection	Not applicable	New liquid manure system installed, no standing water, dry conditions, low odour (manure and composting areas)
May 23, 2015	Committee Complaints	Local concerns regarding flies and odour	Matters discussed in committee meeting and brought to Government's attention via email.
Jul. 9, 2015	Scheduled Site Inspection	Not applicable	Concerns over pooling water around the site, minor housekeeping required, presence of flies noted around standing water and near old manure storage area.
Jul. 5, 2015	Registered letter for Viking	Results of site inspection July 9, 2015	Housekeeping required regarding minor amounts of waste and standing water concerns identified and require the correction of these issues.
Oct. 7, 2015	Scheduled Site Inspection	Not applicable	No concerns/compliance issues noted during site visit.
Aug. 30, 2016	Scheduled Site Inspection	Not applicable	No concerns/compliance issues noted during site visit.
Mar. 22, 2018	Scheduled Site Inspection	Not applicable	No concerns/compliance issues noted during site visit.
Aug. 3, 2018	Local Compliant Driven	Local odour complaints	Investigated by Environmental Protection Officer (EPO) strong smell noted adjacent to site, winds and high summer temperatures may be exacerbating factors
Aug. 10, 2018	Local Complaint Driven	Local odour complaints	Investigated by EPO. Caplin used in feed stock, waste disposed of in compost pile. Odour appears to originate from mink feed preparation area. Strong winds and high summer temperatures appear to be exacerbating factors. Meeting with Viking Fur to discuss steps to minimize and remedy odours on site, more frequent cleaning of food prep area and increase staff as necessary to implement changes.

Date [1]	Reason/ Source	Complaint Claims	Result
Aug. 22, 2018	Local Complaint Driven	Local odour complaints	Investigated by EPO. Letter issued to Viking Fur to refrain from adding Caplin to their mink feed, no concern with compost or manure storage. EPO recommended better housekeeping practices. Letter issued to Viking Fur re violation of clause 33 of CofA.
Sept. 4, 2018	Scheduled site inspection	Not applicable	No concerns or compliance issues noted during site visit
Sept. 19, 2018	Local complaint driven	Local odour complaints	Investigated by EPO, no significant odours during visit, no fly concerns, no evidence of non-compliance issues identified.
Oct. 17, 2018	Local compliant driven	Odour complaints, farm spreading stuff and killing trees, farm not in compliance	Investigated by EPO, typical odours experienced during site visit, no evidence of farm spreading anything that is killing trees
NOTE: [1] As of April 19, 2021			

In addition to the historical complaint analysis, residents in the communities adjacent to Viking's operations were asked to participate in a community odour assessment. In total, 19 individuals and businesses were surveyed between August 4, 2020 and September 12, 2020 (See Figure 5-5). During this period, Viking Fur spread liquid manure on their pasture and forage lands between August 18 and August 21 and between August 25 and August 26, 2020 and conducted regular farm activities. Individual residents were requested to complete a daily odour diary, that detailed any odour encountered, characteristics of the odour (if encountered), and meteorological information applicable to the event (e.g., weather conditions, temperature, wind strength, and wind direction).

The community odour survey used a reference scale to quantify odour type, intensity, and persistence. Odour type is described in Figure 5-4, while odour intensity and odour persistence are described as follows:

Odour Intensity:

- Level 0: No odour
- Level -1: Mildly unpleasant
- Level -2: Moderately unpleasant
- Level -3: Unpleasant
- Level -4: Offensive

Odour Persistence:

- Level 0: No odour
- Level 1: Short-lived
- Level 2: Intermittent
- Level 3: Persistent

The results from this community odour survey are summarized in Table 5-4 and detailed in Appendix A. Of the 500 odour survey samples, odour events were recorded 10.4% of the time (or 51 unique events) over the 40-day odour observation period. More specifically, the respondents reported that 82% of the odour events occurred downwind (north/north-west) of the Viking farm and 18% of the odour events occurred upwind (south/south-east) of Viking Fur's farm. On the days when Viking spread liquid manure on their pastureland, 11.8% of the odour survey responses identified an odour event. On days when Viking did not spread liquid manure, 9.8% of the surveys identified an odour event. Although, it should be noted that manure was not spread on the oceanside pasturelands in August 2021.

The majority of odour experienced was either described as Odour Type "1" (fecal, sewer, fishy, ammonia) or "3" (rancid, sour), representing about 70% of the odour events. Odour Type 1 represented the highest fraction of odour occurrences at 51.0 % while Odour Type 3 occurred 25.5% of the time. There were lesser reports of Odour Type 4 (putrid/dead animals), Odour Type 5 (waste), and Odour Type 6 (Sweet), which together accounted for approximately 23% of the recorded odour events. Generally, the odour intensity was evenly distributed across types -1, -2, and -3 (mildly unpleasant, moderately unpleasant, and unpleasant) at 23.5%, 27.5%, 35.3%, respectively. 11.8% of the observed odour events were considered offensive (-4).

Figure 5-4: Survey Odour Types

Table 5-4: Frequency of Reported Odour Types and Intensities

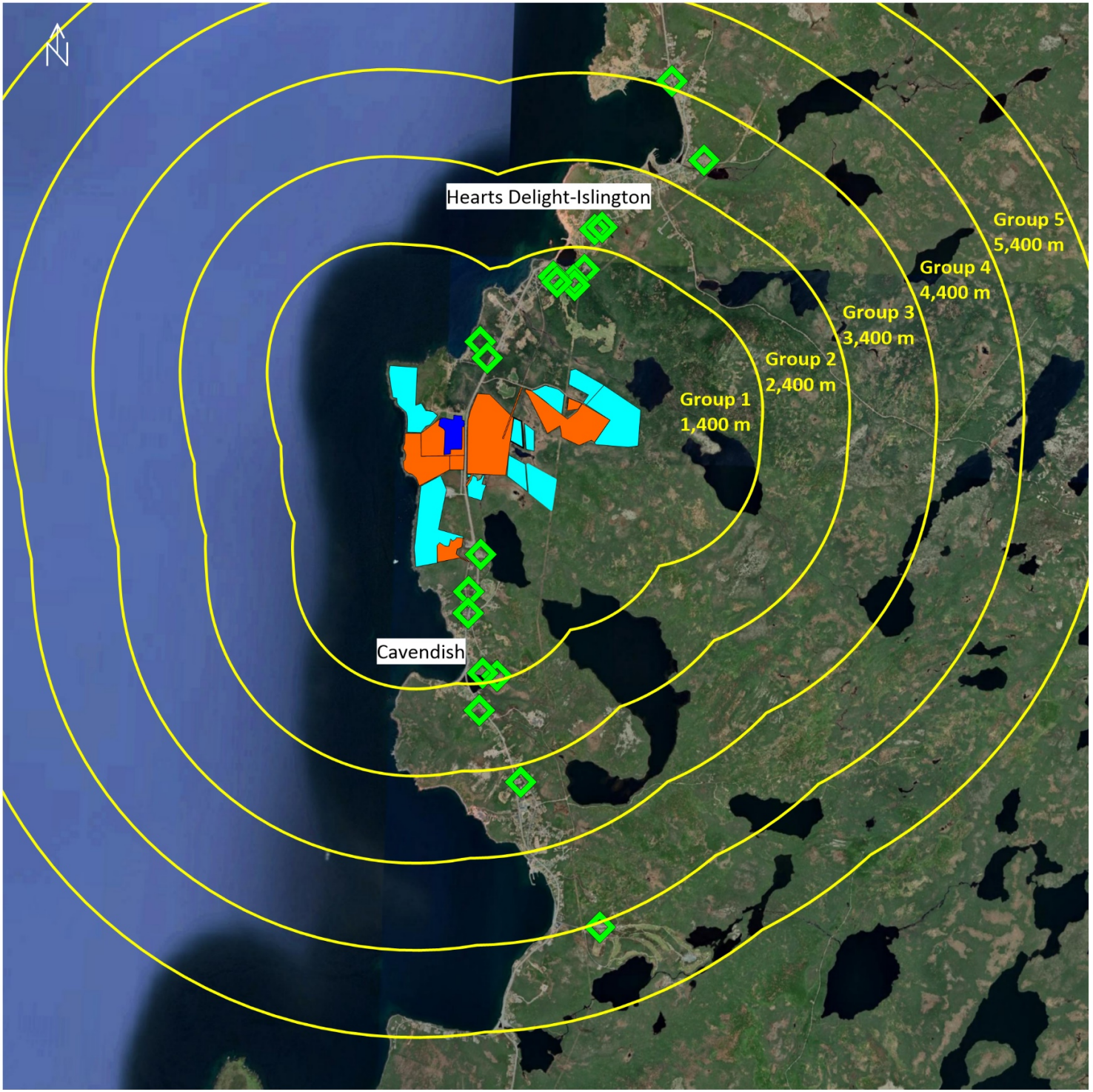
		Odour Type [1]					
		1	**2**	**3**	**4**	**5**	**6**
Odour Intensity [2]	**-1**	5	0	2	1	1	3
	-2	6	1	5	0	3	0
	-3	9	0	8	2	1	0
	-4	2	0	0	0	0	0

NOTES:
[1] 1-Fecal, Sewer, Fishy, Ammonia; 2-Sulphur, Cabbage, Natural Gas; 3-Rancid, Sour; 4-Putrid, Dead Animals; 5-Waste; 6-Sweet
[2] -1 Mildly Unpleasant; -2 Moderately Unpleasant; -3 Unpleasant; -4 Offensive

The World Health Organization (WHO) defines a nuisance threshold as being that concentration at which not more than a small proportion of the population (less than 5%) experiences annoyance for a small part of the time (less than 2%) [15]. In the absence of an alternative definition of a nuisance odour threshold, the WHO definition can be used as one alternative in evaluating the odour survey observations. On this basis, there is sufficient evidence to suggest that the WHO nuisance criteria would be exceeded at some sensitive receptors in close proximity of the farm (Group 1 and 2).

It is also important to note that there were additional sources of odour identified by respondents in the survey that may not have been related to Viking's operations. On August 29, 2020, several respondents in close proximity to the Viking farm reported odours that may have been related to maintenance/construction work that was being completed on the Islington sewer system. In addition, Alfred Bishop's farm in Islington may be another potential source of odours that contributed to recorded odour events in the survey. This farm has about 25 acres of cleared farmland, which is used for sheep pasture and hay land and also maintains turkeys, goats, and cows. Viking currently has an agreement to spread manure at this farm twice yearly in the spring and in the fall. Of particular interest, one respondent noted that odour (Type 1, Mildly Unpleasant, Intermittent) was observed on August 19, 2020; however, the source may have been from Alfred Bishop's farm as chicken manure was reportedly spread on the fields during this period.

From the odour surveys, 83.7% of the entries reporting farm odour recorded a temperature of "warm" or "hot". Mink manure is known to have high concentrations of ammonia, which under certain environmental conditions may be volatilized resulting in the formation of farm odours [6]. Odour complaints tend to increase proportionally to increases in ambient temperature, humidity, and wind speed [11] [9]. Additional analysis of meteorological effects is provided in Section 5.2.1.1.



LEGEND:

- Viking Mink Farm
- Current Pasture/Forage Lands
- Proposed Lease Pasture/Forage Lands
- Receptor Groupings (1-5)
- Odour Survey Locations

NOTES:

SCALE:

1000 2000 m

REFERENCE:

UTM Zone 22T, WGS84

Viking Fur

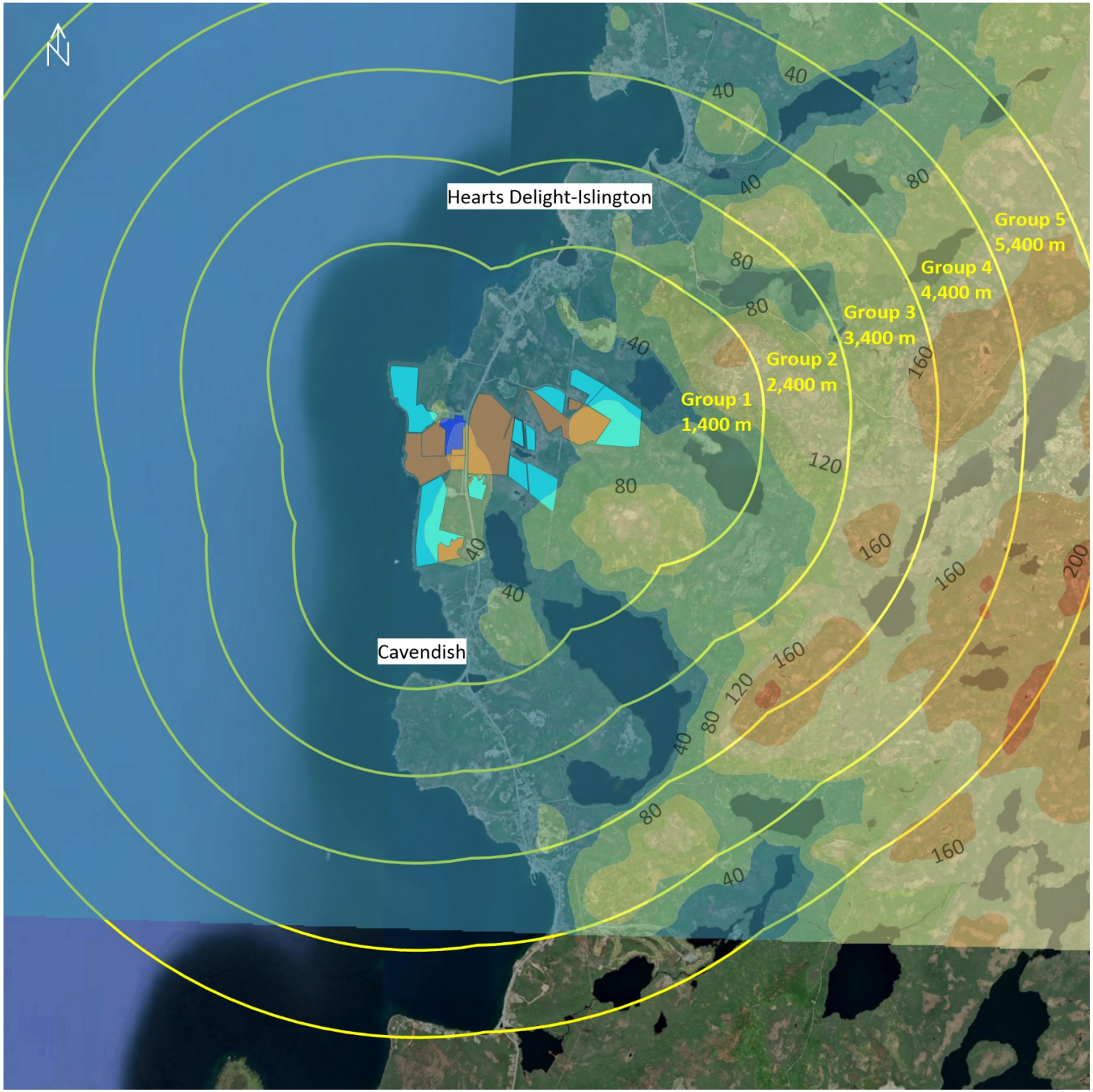
Odour Survey Locations

Drawn By:	Approved By:	Figure No.:
PLK	NS	5-5
Date:	Project No.:	
August 2021	SX20-0003	

5.2.4 Terrain

Obstacles to wind flow such as hills, trees and buildings increase the roughness of the terrain and, accordingly, the dispersion of the odour plume. Variations in terrain elevation can also change the shape of the plume. Generally, dispersion is increased when winds carry the plume upslope while downslope winds lead to less dispersion and tend to concentrate odours in lower lying areas.

The local topography in the study area is presented in Figure 5-6. Generally, the terrain elevation is relatively flat on the east side of the study area and gradually increases inland. The increasing terrain profile east of the farm is expected to influence the manner in which odour releases are dispersed. Odour releases would tend to follow the general topography of the land, channeled by the higher hill elevations, with consideration to the dominant wind directions (i.e., dispersing in a north-easterly direction). As such, downwind receptors within these lower lying areas would be expected to be at a higher risk of odour exposure. It is also worth noting that the Farm is located at a slightly higher elevation (40m) than many of the sensitive receptor locations, which may also influence the manner is which odours are dispersed.



LEGEND:

- Viking Mink Farm
- Current Pasture/Forage Lands
- Proposed Lease Pasture/Forage Lands
- Receptor Groupings (1-5)
- Terrain Elevation (m)

NOTES:

SCALE:

1000 2000 m

REFERENCE:

UTM Zone 22T, WGS84

Viking Fur

Terrain Map

Drawn By:	Approved By:	Figure No.:
PLK	NS	5-6
Date:	Project No.:	
August 2021	SX20-0003	

5.3 RECEPTOR SENSITIVITY

5.3.1 Land Use and Amenity

Viking Fur is located in an agricultural area within the Town of Cavendish, NL in close proximity to residences to the north and south as well as commercial tourism operations from the boundary of Viking's farm and pasture lands. The potential loss of amenity was evaluated based on historical odour complaints and from the odour survey completed in the summer of 2020. Viking has received historical odour complaints and has been working to implement odour mitigation measures to reduce nuisance odour complaints affecting the local community (see Table 5-3). Over the 40-day odour survey period in summer of 2020, 10.2% of the 500 received odour surveys identified odours. However, it is important to note there are other potential sources of odour in the community that may be contributing to odour (i.e., other local farms, sewer outfall). There was limited data available to assess these particular source(s) of odour. Another factor is that a portion of the population are already sensitized to the farm odours in the area as a result of repeated exposure.

The Tourism and Potential Effects on Tourism Industry Component Study [16] indicated that:

- Most businesses south of the farm seldom detected odours at their businesses unless there was a northerly wind (blowing from), which does not frequently occur;
- Some businesses to the north of farm have expressed concern about strong odours (particularly in August) and reported that a number of clients had to be refunded. Concern was also raised about losses in future business revenue and deferring the expansion of operations due to odours.

On the basis of this information, some receptors in close proximity to the Farm would experience some loss of amenity. Particularly, for those that are located downwind of the Mink farm and fields where manure spreading occurs.

5.3.2 Duration and Frequency of Exposure

The duration and frequency of exposure of a local resident/tourist around their home/rental and in town would be governed by a number of factors, including:

- Their proximity to Viking's farm and pasture and forage lands;
- The specific activities occurring at the farm at a given time or day, depending on the mink life cycle and time of year;
- The frequency and duration of seasonal manure spreading activities (2-3 times per year);
- The prevailing meteorological conditions in the relation to the farm and pasture and forage lands (temperature, humidity, wind direction); and
- The time spent by residents/tourists outdoors and indoors with windows open when an odour event(s) occur and where they experience material discomfort, a loss of enjoyment of their property or there is interference with the normal conduct of business.

Generally, residents are expected to be regularly present for extended periods as part of the normal use of their properties. Tourists are also expected to be regularly present during the period of their stay, which would be anticipated to be in the range of several days to weeks.

In the odour survey, respondents reported a range to durations where odour exposure occurred during the 51 recorded events:

- 25% of respondents reported that the odour events occurred for less than 2 hours.
- 29% of respondents reported that the odour events occurred for 2-4 hours.
- 4% of respondents reported that the odour events occurred for 5-8 hours.
- 50% of respondents reported that the odour events occurred for the entire day.

In terms of odour persistence, 47.1% of the observed odour was deemed persistent (rank 3), 19.6% of the observed odour was deemed to be intermittent (rank 2), and 21.6% of the observed odour was deemed to be short-lived (rank 1). Odour Type "1" (fecal, sewer, fishy, ammonia) and "3" (rancid, sour) were described as the most persistent odours (68% and 41% ranked -3) while Odour Type 2 (sulphur), Type 4 (putrid/dead animals), Odour Type 5 (waste), and Odour Type 6 (Sweet) were generally considered more intermittent and short-lived.

Table 5-5: Frequency of Reported Odour Types and Intensities

		Odour Type [1]					
		1	**2**	**3**	**4**	**5**	**6**
Odour Persistence [2]	**-1**	2	1	4	1	0	2
	-2	5	0	2	0	3	1
	-3	15	0	9	2	1	0

NOTES:
[1] 1-Fecal, Sewer, Fishy, Ammonia; 2-Sulphur, Cabbage, Natural Gas; 3-Rancid, Sour; 4-Putrid, Dead Animals; 5-Waste; 6-Sweet
[2] Level 0 – No odour; Level 1 – Short-lived; Level 2 -Intermittent; Level 3 – Persistent

5.4 RISK ASSESSMENT

5.4.1 Mink Farm and Manure Spreading

The existing mink farm and manure spreading activities has been assigned a "**High**" Odour Source Potential, given the extent of the operations and manure spreading activities, the overall characteristics of the mink manure, and the current control mechanisms that are employed. The relevant magnitude, unpleasantness and mitigation/control metrics (from Table 4-4) are presented below:

Magnitude

- Larger permitted processes of odorous nature (i.e., manure handling, spreading)
- Materials usage thousands of tonnes/m^3 per year
- Very odorous compounds, having very low odour detection thresholds

Unpleasantness

- Compounds/odours having unpleasant (-2) to very unpleasant (-4) hedonic score.

Mitigation/Control

- Substantial mitigation measures in place, but residual odour potential remains

The Pathway Effectiveness for the existing farm and manure spreading activities is considered **Ineffective** for Groups 1 receptors (within 1,400 meters of the farm and manure spreading operations), given the distance from the operations, the prevailing wind directions (downwind) and local topography. Pathway Effectiveness for Group 2 and 3 receptors is considered to be **Moderately Effective**, and **Highly Effective** for Group 4 and 5 receptors. These were used to develop Risk of Odour Exposure rankings per Table 4-2 for use in identifying the risk of an odour effect. The Risk of Odour Exposures were determined to be:

- Group 1 receptors: **High Risk**;
- Group 2 and 3 receptors: **Medium Risk**; and
- Group 4 and 5 receptors: **Low Risk**.

Receptor sensitivity has been assigned a rating of **Medium** for Group 1, 2 and 3 receptors and **Low** for Group 4 and 5 receptors, based on the community odour complaints, the potential loss of amenity and the anticipated duration/frequency of odour exposures. Based on the above and the procedure in Table 4-3, the Risk of an Odour Effect from the existing farm and manure spreading activities is as follows:

- Group 1 and 2 receptors: **Moderately Adverse**;
- Group 3 receptors: **Slightly Adverse**; and
- Group 4 and 5 receptors: **Negligible**.

The determination of the above rankings is shown visually in Table 5-6. The presence of a **Moderately Adverse** effect at the most sensitive receptors warrants consideration to additional controls to reduce odour risks. Supplemental odour controls are outlined in Section 6.1.

Table 5-6: Likely Odour Effects Existing Mink Farm and Manure Spreading Activity

Receptor Details and Location	Source Odour Potential	Pathway Effectiveness		Odour Exposure		Receptor Sensitivity		Likely Odour Effect
Receptors Group 1	High	Ineffective		High Risk		Medium		Moderately Adverse
Receptors Group 2	High	Moderately Effective		Medium Risk		Medium		Slightly Adverse
Receptors Group 3	High	Moderately Effective		Medium Risk		Medium		Slightly Adverse
Receptors Group 4	High	Highly Effective		Low Risk		Low		Negligible
Receptors Group 5	High	Highly Effective		Low Risk		Low		Negligible

Note that the application of manure on additional pasture and forage land areas is not expected to significantly change the risk profile noted above. However, it is worth noting that Group 1 receptors located near Proposed Field 2 may experience a higher receptor sensitivity given the possibility that liquid manure spreading could occur closer to their properties. Additional controls related to liquid manure spreading may be warranted for Proposed Field 2 (i.e., distance setbacks, eliminating spreading during summer, etc.). Supplemental odour controls are outlined in Section 6.1.

5.4.2 Proposed Cattle Pasturing

The proposed cattle farming operation has a lower overall Source Odour Potential given the low densities of animals within the pastureland areas, the high degree of manure dispersal within these areas and that a constructed area to manage/store cattle manure is not necessary. Overall, the odour potential from the proposed cattle operation is considered a have **Low** odour potential. The relevant magnitude, unpleasantness and mitigation/control metrics from Table 4-4 for cattle farming are presented below:

Magnitude

- Small size permitted processes (i.e., 100 cattle plus offspring);
- Materials usage tens of tonnes/m^3 per year;
- Area sources of tens m^2 (i.e., grazing areas)

Unpleasantness

- Compounds/odours having neutral (0) to unpleasant (-2) hedonic score.

Mitigation/Control

- Effective, tangible mitigation measures in place leading to little or no residual odour potential.

Despite the overall low odour potential, the Pathway Effectiveness for the proposed cattle farming is still considered **Ineffective** for Groups 1 receptors (within 1,400 meters and downwind of the farm operations), given the separation distances, prevailing wind directions and topography. Pathway Effectiveness for Group 2 and 3 receptors is still considered **Moderately Effective**, and **Highly Effective** for Group 4 and 5 receptors. These ratings result in **Low Risk** for Group 1 receptors, and **Negligible Risk** for Groups 2 to 5 (see Table 5-7).

Receptor sensitivity is considered **Medium** for Group 1, 2 and 3 receptors and **Low** for Group 4 and 5 receptors, based on historical community odour complaints, the potential loss of amenity and anticipated duration/frequency of odour exposures.

Based on the above, the likely effect from the release of odours from the cattle farming operation is considered **Negligible** at all receptor groups and no further mitigative controls are considered necessary.

Table 5-7: Likely Odour Effects Cattle Production

Receptor Details and Location	Source Odour Potential	Pathway Effectiveness		Odour Exposure		Receptor Sensitivity		Likely Odour Effect
Receptors Group 1	Low	Ineffective		Low Risk		Medium		Negligible
Receptors Group 2	Low	Moderately Effective		Negligible Risk		Medium		Negligible
Receptors Group 3	Low	Moderately Effective		Negligible Risk		Medium		Negligible
Receptors Group 4	Low	Highly Effective		Negligible Risk		Low		Negligible
Receptors Group 5	Low	Highly Effective		Negligible Risk		Low		Negligible

5.4.3 Cumulative Odour Effect

The cumulative odour effect is presented in below and represents the combination of the existing mink farm, current and future manure spreading activities, and the proposed cattle farming operation, including future pasture and forage land usage. Overall, the Source Odour Potential remains **High**, given the extent of the current and proposed operations and manure spreading activities, the overall characteristics of the mink manure, and the current control mechanisms that are employed. The addition of beef cattle is not expected to increase the cumulative odour risk from the farm.

The overall Pathway Effectiveness is considered **Ineffective** for Groups 1 and 2 receptors, **Moderately Effective** for Group 3 receptors and **Highly Effective** for Group 4 and 5 receptors given the distance from the operations, prevailing wind directions and topography. Similarly, receptor sensitivity is **Medium** for Group 1, 2 and 3 and **Low** for Group 4 and 5 receptors, given the current (and potential future) community odour complaints, the potential loss of amenity and anticipated duration/frequency of cumulative odour exposures.

Based on the above, the likely cumulative effect from the release of odours is considered **Moderately Adverse** at the most sensitive Group 1 receptors, **Slightly Adverse** at Group 2 and 3 receptors and **Negligible** at Group 4 and 5 receptors and is attributed to the existing mink farm. The presence of a **Moderately Adverse** effect at the most sensitive receptors warrants consideration to additional controls to reduce odour risks. Supplemental odour controls are outlined in Section 6.1.

Table 5-8: Likely Cumulative Odour Effect

Receptor Details and Location	Source Odour Potential	Pathway Effectiveness		Odour Exposure		Receptor Sensitivity		Likely Odour Effect
Receptors Group 1	High	Ineffective		High Risk		Medium		Moderately Adverse
Receptors Group 2	High	Moderately Effective		Medium Risk		Medium		Slightly Adverse
Receptors Group 3	High	Moderately Effective		Medium Risk		Medium		Slightly Adverse
Receptors Group 4	High	Highly Effective		Low Risk		Low		Negligible
Receptors Group 5	High	Highly Effective		Low Risk		Low		Negligible

6.0 ODOUR MANAGEMENT

The application of good working practices and process controls is fundamental to minimising the formation of odours and their subsequent release to the atmosphere. Containment and mitigation of odour at the source through the implementation of standard operating procedures (administrative controls) and physical controls (i.e., liquid waste management system) are effective methods that help control odour formation and dispersal.

Viking Fur has implemented a number of these controls, which have helped mitigate odour releases from the farm operations and during the spreading of manure on local forage lands. While considerable effort has been made by Viking Fur to control odours, there continues to be a **Moderately to Slightly Adverse** risk of odour effects in the community at the closest sensitive receptors (primarily Group 1 and 2) to the farming operations.

To further Viking Fur's efforts to reduce odour effects, an initial series of supplemental odour control options (short and long-term) are provided in Table 6-1 (and detailed in Section 6.1), which if implemented, in whole or in part, may help reduce overall community odour impacts. The implementation of planned or future odour controls should be completed in a stepwise approach, whereby a specific control or group of controls will be tested/implemented followed by consultation and engagement with the community to determine the effectiveness of the control(s). Ineffective controls should be analysed to determine if improvements or adjustments can be made to increase their efficacy or if alternatives will need to be considered.

A detailed evaluation of the viability of each of these options has not been completed at this time due to farm access restrictions as a result of the COVID-19 pandemic. A comprehensive evaluation will be completed to assess the proposed (and/or alternative) odour controls outlined in Section 6.1, which will be used to support the development of a more detailed OMCP following the completion of the EIS. The suggested content for the OMCP is presented in Section 6.2.

6.1 SUPPLEMENTAL ODOUR CONTROL OPTIONS

6.1.1 Administrative Controls

General

- Develop and implement a comprehensive community engagement, communication and monitoring program that:
  - Establishes and maintains an open line of communication with the community so that odour complaints or events can be reported in a timely manner and provide suitable information to guide an investigation into each odour event (i.e., date/time, odour type, persistence, wind conditions, etc.). This approach can also be used to help evaluate the effectiveness of current and future odour control practices.
  - Provide regular communications to the community on farm operations/activities and upcoming community events that the farm is participating in.

- Develop and implement a complaints management process that responds to each reported odour complaint or event and includes a detailed investigation that considers the following:
  - Farm activities that were occurring at the time of the incident and were likely contributing to the odour event;
  - Whether there was an abnormal event that took place and contributed to the odour event;
  - Whether the activities were short-term or continuous (ongoing) and when they would cease;
  - Wind direction/speed, temperature and humidity at the time of the incident; and
  - The location of the receptor and any particular amenity related concerns.

  A formal response to each complaint should be provided within 24 hours, or as soon as possible thereafter. Included in the response will be an acknowledgement of the concern, the reason for the odour event (i.e., results of the investigation), and the steps taken to prevent future odour events. A follow-up program would also be completed 1-2 weeks after the complaint to review progress and obtain additional feedback from the complainant.

- Develop and implement a preventative maintenance and inspection/audit program. The preventative maintenance program would be focussed on critical operating systems (including odour controls) where failures could be prevented with regular maintenance. In addition, a comprehensive inspection program would support and enhance the preventative maintenance program, by focussing on routine inspections of critical equipment, farming practices, odour controls and where possible aid in the identification of abnormal/upset events may lead to greater odour generation and complaints.

- Develop and implement standard operating procedures for all farm activities that have the potential to generate odour. Standard operating procedures (SOPs) provide clear instructions to employees to ensure that (a) all required steps in a given activity are completed in an organized manner and (b) all necessary odour controls are implemented and maintained in accordance with legal and other obligations.

- Provide awareness and job-specific training for all farm employees on the odour management and control plans, including, but not limited to, sources of odour, controls systems, abnormal/upset conditions, inspections/effectiveness checks, complaints, spills, housekeeping, etc.

Manure Spreading

- Recommend installing an on-site meteorological station to better understand local weather conditions suitable for manure spreading. In particular, this information should be used when selecting appropriate periods for the spreading of manure on pasture and forage lands. Manure spreading should be avoided under the following conditions:
    - Low wind speeds/calms winds (i.e., less dilution effects);
    - Winds blowing towards sensitive receptors (where possible);
    - High ambient temperatures (i.e., >20 C);
    - High relative humidity (i.e., >80 %); and

  Ideally, spreading manure just before a light rain on a cool, cloudy day, or in the early morning or evening (versus the middle of the day) will help to minimize ammonia volatilization [17].

- Consider using a farm-specific weather forecasting model to predict future weather conditions. This type of forecast modelling could be used to predict weather conditions up to 36-48 hours in advance and would generally be more accurate than currently available forecasting in the area, which is based on a meteorological station in St. John's (i.e., too far away to provide useful information).

- Avoiding manure application on weekends, holidays and during high season for tourism operators (summer months). In particular, eliminate manure spreading on oceanside fields during summer months.

- Evaluate options to phase out summer spreading on fields in close proximity to sensitive receptors.

- Evaluate the application rate of liquid manure spread on existing and proposed fields to (a) reduce the overall volume of manure spread per hectare and (b) if the periods between applications can be optimized. Evaluate the nutrient content of the manure regularly to ensure that application rates match crop nutrient requirements (i.e., soil type, yield goals, and nitrogen availability) [17].

6.1.2 Physical Controls

To further reduce odours from the farm the following supplemental physical control measures could be employed:

Cattle Grazing

- Biweekly inspections of the entire pastureland areas to ensure that there are no accumulations of manure

Mink Barns and Liquid/Solid Manure Separator

- Consider installing dense/high vegetative windbreaks or shelterbelts downwind of the Mink barns (and other structures). Windbreaks can enhance dispersion by promoting air turbulence and also act as a filtration barrier where particles/odours can be partially retained [18].
- Maintain good ventilation flows to minimize excess moisture, humidity and reduce odour generation potential [19]. Consider the potential of using mechanical ventilation and if a biofilter/scrubber system could be used to control ammonia and odour emissions from the barns (if technically and economically feasible).
- Investigate the potential for dietary changes/manipulation to help reduce ammonia/odour formation at the source (i.e., reducing crude protein, fermentable carbohydrates, amino acid supplements) (if technically and economically feasible).
- Ensure that bedding material is properly maintained/changed to reduce moisture content with consideration to normal mink life cycle (i.e., periods when young are separated from mother). Frequently changing bedding can reduce ammonia volatilization by trapping in organic materials and creating a stable form of nitrogen for use on pasture and forage lands.
- Continue to apply hydrated lime underneath the mink cages on a regular basis to minimize odour formation.
- Employ dust suppression/control methods to minimize potential for odour adsorption onto particles.

Open-Top Manure Storage Tanks

- To reduce potential nuisance ammonia/odour emissions, a floating cover or roof may be placed on top of the liquid manure tanks. There are a number of potential materials that can help to reduce odour emissions from open-air manure storage facilities, including:
    - Natural covers: chopped straw and other crop residues, woodchips and sawdust, perlite, expanded clay, vegetable oil;
    - Synthetic covers: permeable covers (plastic granules, rubber granules, hydrophobic powder), impermeable covers (plastic films) and tented roofs; and
    - Composite covers: combination of different materials as noted above [10], [20], [21], [18].

  The material type and thickness will need to be evaluated as part of the design process to ensure the optimum configuration. Note that the use of covers can also increase nitrogen content of the slurry, thereby increasing its fertilizer value [12].

- If the cover option does not result in a significant reduction in odour, consider evaluating an anaerobic digester / membrane filtration system (nutrients) equipped with a bio-filter/scrubber to further treat air emissions. This method may reduce odour potential in the liquid manure, as well as generate greenhouse gas reductions. It may be possible, to leverage grant agencies to fund this type of investigation under the Climate Change Challenge Fund (CCCF). CCCF is jointly funded by the Government of Newfoundland and Labrador and the Government of Canada with support from the Low Carbon Economy Leadership Fund and is delivered by the Department of Municipal Affairs and Environment.

Carcass Composting

- Investigate the potential to use additives/amendments for ammonia and odour reduction at the source;
- Investigate whether extending the maturation phase would reduce odour potential.

Manure Spreading

- During application of manure, minimizing contact surface areas with the air by applying manure as close to the surface as possible.
- Investigate whether alternative spreaders could be used to improve application rates/uniformity of spread.
- Where possible, retain windbreaks or shelterbelts around existing or proposed pasture and forage land areas.

Table 6-1: Odour Source and Controls Summary

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)		Tentative Implementation Schedule [1]
		Current	Potential Future	
Cattle Farming				
Cattle grazing	Year-round grazing in pasture and forage lands	▪ Low density of cattle ▪ High natural dispersal of manure	▪ Biweekly inspections of the entire pastureland areas to ensure that there are no accumulations of manure	▪ Short Term
Mink Production				
Mink barns and liquid/solid manure separator	Mink rearing/feeding barns	▪ Passive ventilation ▪ Approved manure management plan and liquid and solids waste management system (gutter system, backwash) ▪ Regular changing of bedding ▪ Addition of hydrated lime undernearth mink cages ▪ Cleaning and disinfection protocols ▪ Prompt removal of mortalities ▪ Composting of manure solids and collection of liquids in storage tanks ▪	▪ Installing dense/high vegetative windbreaks or shelterbelts ▪ Evaluate the potential of using mechanical ventilation and if a biofilter/scrubber would be beneficial ▪ Investigate the potential for dietary changes/manipulation to reduce ammonia formation ▪ Implement dust control measures to reduce odour adsorption ▪ Ensure that bedding material is properly maintained/changed to reduce moisture content	▪ Longer Term ▪ Longer Term ▪ Longer Term ▪ Longer Term

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)		Tentative Implementation Schedule [1]
		Current	Potential Future	
Manure storage tanks	Open top tanks for the storage of liquid manure	▪ Large storage capacity to control farm wide liquid manure year-round ▪ Emergency shut-off valves and safety mechanisms to control accidental releases ▪ Center agitation system	▪ Apply a storage tank cover (natural, synthetic or composite covers) ▪ Investigate option of installing an anaerobic digester/membrane filtration/bio filter/scrubber system	▪ Short Term ▪ Longer Term
Feed Kitchen / Storage / Distribution	Preparation and storage of mink feed (chicken and fish offal)	▪ Receiving, testing, preserving, and cold storage of feed stock ▪ All mink feedstock delivered to site must be in sealed/leak proof containers or in vehicle where tarpaulin/other covering is attached ▪ Feed covered when not in use and disposed of in a timely manner ▪ Feed cooled or frozen within 24 hours of receipt ▪ When freezer storage >90%, no further feed is accepted until space is available ▪ Feathers covered/contained, no more than 1 truck load of feathers on site at any time, disposed of at approved waste facility ▪ Feed kitchen washed down daily and disinfected weekly, all fish vats/pans cleaned immediately after product is taken out ▪ All wastewater from wash down area is disposed of through septic system	▪ No additional controls identified at this time	▪ NA

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)		Tentative Implementation Schedule [1]
		Current	**Potential Future**	
Carcass Composting	Windrows composting of carcasses	▪ Formal carcass disposal plan ▪ Covered with a roof ▪ Impermeable concrete floor ▪ Windrow temperature and moisture are monitored and recorded on file daily ▪ Only solids from manure system and carcasses are composted ▪ Monitoring and record keeping (temperature, moisture content)	▪ Investigate the potential to use additives/amendments for ammonia and odour reduction at the source ▪ Investigate whether extending the compost maturation phase would reduce odour potential	▪ Longer term
Other Waste and Wastewater Management	Waste other than manure and carcasses	▪ Waste generated collected in refuse containers and disposed of on weekly basis at an approved site ▪ Wastewater deposited in septic field after separator removes solid matter for composting ▪ Farm drainage system prevent standing water build-up	▪ No additional controls identified at this time	▪ NA
Manure spreading				
Manure spreading	Land application of liquid manure	▪ Spray nozzles close to ground ▪ Checking wind conditions based on local weather forecasts ▪ Community notices within 48 hours of manure spreading ▪ Manure will not be spread on frozen or snow covered ground	▪ Install weather station to track wind speed, direction, temperature, humidity, etc. ▪ Consider using a farm-specific weather forecasting model to predict future weather conditions ▪ Avoiding manure application on weekends, holidays and during high season for tourism operators (summer	▪ Short-term ▪ Medium-term ▪ Short-term

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)		Tentative Implementation Schedule [1]
		Current	**Potential Future**	
		▪ Composted solid waste spread on Viking's land base once per year or transported to other locations	months). In particular, eliminate manure spreading on oceanside fields during summer months. ▪ Evaluate options to phase out summer spreading on fields in close proximity to sensitive receptors ▪ Evaluate the application rate of liquid manure spread on existing and proposed fields to (a) reduce the overall volume of manure spread per hectare and (b) if the periods between applications can be optimized. ▪ Evaluate the nutrient content of the manure regularly to ensure that application rates match crop nutrient requirements (i.e., soil type, yield goals, and nitrogen availability) [17]. ▪ During application of manure, minimizing contact surface areas with the air by applying manure as close to the surface as possible. ▪ Investigate whether alternative spreaders could be used to improve application rates/uniformity of spread. ▪ Where possible, retain windbreaks or shelterbelts around existing or	▪ Short-term ▪ Medium-term ▪ Medium-term ▪ Medium-term ▪ Short-term ▪ Short-term ▪ Short-term

Principle Odour Sources	Brief Description	Odour Controls (Administrative and Physical)		Tentative Implementation Schedule [1]
		Current	Potential Future	
			proposed pasture and forage land areas **Also see manure storage tanks above (anaerobic digester)*	

NOTES:
[1] Short-term = <6 months from approval; medium term = 6 months to 1 year from approval; long-term = 1 to 3 years from approval.

6.2 ODOUR MANAGEMENT AND CONTROL PLAN FRAMEWORK

As noted above, a formalized OMCP should be developed for the Farm operations as a whole. The OMCP would form part of Viking's operational management system and address how odours will be managed and controlled so as to prevent or minimise community impacts. As well as covering normal operations, it should anticipate and plan for abnormal events and foreseeable accidents and incidents.

The OMCP should consider using an environmental management system (EMS) framework, which promotes the consistent and regular review, evaluation, and improvement of facility performance. The most commonly used framework for an EMS is the International Organization for Standardization (ISO) 14001 standard. Established in 1996, this framework is the official international standard for an EMS and is based on the Plan-Do-Check-Act methodology. The basic elements of an EMS include the following:

- Defining policies and setting goals;
- Analyzing environmental impacts, legal requirements and other obligations;
- Setting objectives and targets to reduce impacts;
- Establishing programs to meet these objectives and targets;
- Monitoring and measuring progress in achieving the objectives;
- Ensuring employees' environmental awareness and competence; and,
- Reviewing progress and making improvements.

The OMCP should also consider the following key elements:

Site Details

- A process description, particularly describing odorous, or potentially odorous, activities or materials used;
- Identification of all the odour release points for each of the activities;
- Identification of the sensitive receptors within the area of influence that could be impacted;
- A description of the meteorological conditions prevailing at the site, especially wind direction; and
- A description of local topographical conditions.

Current, Routine and Planned Controls Under Normal Conditions

- A description of the routine mitigation/control measures that are used day-to-day under normal operating conditions in the absence of any unusual risk factors; and
- A description of future/planned control measure and a schedule of implementation.

Reasonably Foreseeable Abnormal Conditions and Additional Controls

- Identification of possible risk factors (e.g., adverse weather conditions) and anticipation of reasonably foreseeable odour-related incidents and accidents (e.g., abnormal situations, spillages, breakdown of equipment or abatement) and a listing of the consequences for odours of these risk factors.

- A description of the additional measures (e.g., additional control measures and modifications to operations that will be applied during these periods to deal with these risks and any reasonably foreseeable incidents and accidents).

Triggers For Additional Controls And Checks On Effectiveness

- A description of what would trigger further actions/additional measures, such as:
  - the results of planned routine checks/inspections/surveys on site;
  - meteorological conditions (e.g., temperature above a certain value, wind blowing in a particular direction, or calms); and
  - odour event monitoring on and/or off site, including:
    - odour complaints monitoring
    - monitoring carried out on-site; and
    - monitoring carried out off-site (e.g., by sniff testing, odour diary surveys, etc.), showing non-compliance with any action levels for ambient odour levels.

7.0 CONCLUSIONS

Independent Environmental Consultants (IEC) was retained by Viking Fur Inc. (Viking) to complete an assessment of potential odour risks from their mink and cattle farm located in Cavendish, Newfoundland and Labrador (the Facility) as part of an Environmental Impact Statement (EIS). This assessment evaluated potential odour risks to the local community that are originating from Viking's current mink farm, manure spreading activities and future cattle farming operations.

The potential odour effects were assessed using a qualitative risk assessment approach that was based on an analysis of odour generating activities at the farm, current mitigative measures, historical odour complaints and an odour survey completed by local stakeholders, local meteorological and topographical features of the area and the sensitivity of receptors and potential loss of amenity. Using this data, a qualitative analysis of potential odour risks on local residents was completed by ranking the magnitude of the odour source potential, the effectiveness of the source-receptor pathway with respect to odour dispersal, and the sensitivity of the community to odours.

The risk of an odour effect from the existing farm and manure spreading activities was determined to be **Moderately Adverse** for Group 1 receptors, **Slightly Adverse** for Group 2 and 3 receptors and **Negligible for** Group 4 and 5 receptors. The likely effect from the release of odours from the cattle farming operation was considered **Negligible** at all receptor groups and no further mitigative controls was considered necessary. The cumulative effect from the release of odours was considered **Moderately Adverse** at the most sensitive Group 1 receptors, **Slightly Adverse** at Group 2 and 3 receptors and **Negligible** at Group 4 and 5 receptors. Cumulative odour effects were attributed to the existing mink farm and likely odours from the addition of cattle were considered negligible. The presence of a **Moderately to Slightly Adverse** effect at the most sensitive receptors (Group 1 and 2) warranted consideration to additional controls to reduce odour risks.

Based on the results of the odour risk assessment, a series of supplemental odour management options were recommended for the existing mink farm and manure spreading activities, which included a range of

administrative and physical controls. The implementation of planned or future odour controls should be completed in a stepwise approach, whereby a specific control or group of controls will be tested/implemented followed by consultation and engagement with the community to determine the effectiveness of the control(s). Ineffective controls should be analysed to determine if improvements or adjustments can be made to increase their efficacy or if alternatives will need to be considered.

Further, a framework for an Odour Management and Control Plan (OMCP) should be developed and implemented across the entire farming operation. The OMCP is intended to form part of Viking's operational management system and address how odours will be managed and controlled so as to prevent or minimise community impacts. As well as covering normal operations, it would anticipate and plan for abnormal events and foreseeable accidents and incidents.

8.0 REFERENCES

[1] National Farm Animal Care Council, "Code of Practice for the Care and Handling of Farmed Mink," 2013. [Online]. Available: https://www.canadamink.ca/2013-06_Mink_Code_of_Practice.pdf. [Accessed 23 March 2021].

[2] P. R. W. Mielcarek, "Odor Emission Factors from Livestock Production," Polish Journal of Environmental Studies, 2015.

[3] D. H. P. V. R. O'Neill, "A review of the control of odour nuisance from livestock buildings: Part 3, properties of the odorous substances which have been identified in livestock wastes or in the air around them," Journal of Agricultural Engineering Research, 1992.

[4] Iowa State University, "The Science of Smell Part 3: Odor detection and measuremen," 2004.

[5] B.C. Ministry of Agriculture, "Farm Practice Odour," 2014.

[6] I. Zarkadas, G. Dontis, G. Pilidis and D. A. Sarigiannis, "Exploring the potential of fur farming wastes and byproducts as substrates to anaerobic digestion process," *Renewable Energy,* vol. 96, no. Part B, pp. 1063-1070, 2016.

[7] M. Nørregaard Hansen, "Quantification of odour emission from mink housing units," AgroTech, 2015.

[8] Viking Fur Inc., "Certificate of Approval A-WMS11-04-2010F," 2020.

[9] D. L. Pfost, C. D. Fulhage and J. A. Hoehne, "Odors From Livestock Operations: Causes and Possible Cures," University of Missouri-Columbia, November 2018. [Online]. Available: https://extension.missouri.edu/publications/g1884. [Accessed 23 March 2021].

[10] M. Hellstedt, "Use of Biochar-peat Mixture to Reduce Odour from Animal Farms," *Agricultural Machinery and Technologies,* vol. 13, no. 2, pp. 27-30, April 2019.

[11] A. Atia, "Ammonia Volatilization from Manure Application," 2 May 2008. [Online]. Available: https://www.thecattlesite.com/articles/1387/ammonia-volatilization-from-manure-application/. [Accessed 23 March 2021].

[12] N. E. a. J. D. S.G. Lupis, "Best Management Practices for Reducing Ammonia Emissions: Lagoon Covers," Colorado State University, 2012.

[13] GONL, Service NL, "A Five Year Summary of Environmental Complaints / Concerns for Viking Fur Farm," GONL, 2019.

[14] G. Blackwood, "Personal communication, Complaints History," 2021.

[15] WHO, "Air Quality Guidelines for Europe," Regional Office for Europe, WHO Regional Publications, European Series, No. 91., 200.

[16] Hazen Scarth, "Tourism and Potential Effects on Tourism Industry Component Study," 2021.

[17] J. D. a. N. E. S.G. Lupis, "Best Management Practices for Reducing Ammonia Emissions: Manure Application," Colorado State University, 2012.

[18] P. A. L.-J. J. N. a. S. C. Y. Ubeda, "Strategies to control odours in livestock facilities: a critical review," Spanish Journal of Agricultural Research, 2013.

[19] NFACC, "Code of Practice for the Care and Handling of Farmed Mink," Canada Mink Breeders Association and the National Farm Animal Care, Rexdale, Ontario, 2013.

[20] G. Hörnig, M. Türk and U. Wanka, "Slurry Covers to reduce Ammonia Emission and Odour Nuisance," *Journal of Agricultural Engineering Research,* vol. 73, no. 2, pp. 151-157, June 1999.

[21] M. Guarino, C. Fabbri, M. Brambilla, L. Valli and P. Navarotto, "Evaluation of Simplified Covering Systems to Reduce Gaseous Emissions from Manure Storage," *Transactions of the American Society of Agricultural and Biological Engineers,* vol. 49, no. 3, pp. 737-747, 2006.

[22] S. Herbert, M. Hashemi, C. Chickering-Sears, S. Weis, K. Miller, J. Carlevale, K. Campbell-Nelson and Z. Zenk, "Conserving Ammonia in Manure," 2021. [Online]. Available: https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/ConservingAmmoniainManure09-50.pdf. [Accessed 24 March 2021].

[23] Government of Newfoundland and Labrador, "Environmental Guidlines for Livestock Producers," November 2001.

[24] P. L. J. M. A. McHendry, "Managing Odour Risks at Landfill Sites," MSE Ltd & Viridis, 2002.

[25] J. F. a. G. Clark, "Odour and Air Quality," Department of Agricultural, Food and Nutritional Science University of Alberta, 2004.

[26] Viking Fur Inc., "Registration Pursuant to Section 49 of the Environmental Protection Act," 2019.

APPENDIX A

Detailed Odour Survey Results

Table 8-1: Summary of Odour Survey Results (Events Only)

Date/Time	Distance (km) and Direction [1]	Duration of Odour	Weather Conditions	Temperature	Wind Strength/ Direction [2]	Odour Characteristics		
						Type	Intensity	Persistence
Aug. 8	0.86/NE	2 hours	Dry/Clear	Hot	Light breeze/SW	1	-3	3
Aug. 10, 12:30 PM	3.26/SE	Drove by Viking Fur (very short duration)	Dry/Clear	Hot	Light air	1	-4	ND
Aug. 11, 6:00 PM	3.26/SE	Drove by Viking Fur (very short duration)	Dry/Clear	Warm	Calm	1	-4	ND
Aug. 12, 4:00 PM	2.11/NE	All day	Dry/Clear	Hot	Moderate breeze/SW	3/4 [3]	-3	3
Aug. 12, 7:00 AM	3.26/SE	Drove by Viking Fur (very short duration)	Dry/Clear	Warm	Calm	1	-4	ND
Aug. 13, 12:30 PM	3.26/SE	Drove by Viking Fur (very short duration)	Overcast	Hot	Light breeze/NE	1	-4	ND
Aug. 13, 12:00 PM	0.86/NE	1 hour	Overcast	Warm	Light air/W	ND	-3	3
Aug. 13, 4:00 PM	0.86/NE	30 minutes	Rain	Warm	Calm/SW	1	-4	3
Aug. 14, 1:30 PM	1.89/S	4 hours	-	Warm	Strong breeze/NE	3	-3	3
Aug. 15, 1:30 PM	1.89/S	3 hours	-	-	Light breeze/NE	3	-2	3
Aug. 17, 3:00 PM	2.11/NE	1 hour	Dry/clear	Warm	Light breeze/W	3	-2	2
Aug. 17, 4:15 PM	0.86/NE	hours	Overcast	Warm	Gentle breeze/SW	1	-2	3

Date/Time	Distance (km) and Direction [1]	Duration of Odour	Weather Conditions	Temperature	Wind Strength/ Direction [2]	Odour Characteristics		
						Type	Intensity	Persistence
Aug. 18	1.89/S	3 hours	Dry/clear	ND	Light breeze/NW	3	-2	3
Aug. 18	2.01/NE	Drove near Viking Fur (very short duration)	Dry/clear	Warm	Gentle breeze/SW	ND	ND	ND
Aug. 18	0.86/NE	All day	Dry/clear	Warm	Light air/S	ND	ND	ND
Aug. 19	1.89/S	4 hours	Dry/clear	-	Light breeze/NW	3	-2	3
Aug. 19	2.01/NE	1 hour	Overcast/rain	Cool	Light breeze/NE (evening), SW (morning)	1	-1	1
Aug. 19, 7:00 PM	0.86/NE	Several hours	Dry/clear	Warm	Light air/S	1	-4	3
Aug. 20	2.01/NE	Most of the day	Dry/clear	Warm	Moderate breeze/SW	6	-1	2
Aug. 20, 5:00 PM	2.76/NE	3 hours	Dry/clear	Warm	Moderate breeze/SW	3	-3	1
Aug. 20, 11:15 AM	0.86/NE	Hours	Dry/clear	Warm	Calm/S	1	-2	3
Aug. 22, 8:00 AM	2.76/NE	4 hours	Dry/clear	Warm	Light breeze/SW	1	-1	2
Aug. 23	2.01/NE	10 minutes	Dry/clear	Warm	Light breeze/ SW	6	-1	1
Aug. 24, 1:30 PM	1.89/S	4 hours	Dry/clear	ND	Calm	3	-3	3
Aug. 25, 1:30 PM	1.89/S	5 hours	Dry/clear	ND	Light breeze/SE/NW	3	-3	3
Aug. 25, 6:30 PM	0.86/NE	1 hour	Dry/clear	Warm	Light air/S	1	-3	3

Date/Time	Distance (km) and Direction [1]	Duration of Odour	Weather Conditions	Temperature	Wind Strength/ Direction [2]	Odour Characteristics		
						Type	Intensity	Persistence
Aug. 26, 3:00 PM	2.76/NE	2 hours	Overcast/rain	Warm	Strong breeze/S/SW	3	-3	1
Aug. 27, 5:00 AM	2.76/NE	8 hours	Dry/clear	Warm	Fresh breeze/SW/W	3	-3	3
Aug. 27, Evening	0.86/NE	ND	Dry/clear	Warm	Light air/SW	1	-3	3
Aug. 28	2.11/NE	ND	Overcast	Warm	Moderate breeze/SW	4	-1	1
Aug. 28, 8:00 AM	2.76/NE	4 hours	Dry/clear	Warm	Strong breeze/SW/W	5	-1	1
Aug. 29, 6:00 PM	2.11/NE	3 hours	Dry/clear	Warm	Moderate breeze	1	-2	2
Aug. 29, 8:30 PM	2.01/NE	15 minutes	Dry/clear	Cool	Gentle breeze/SW	6	-1	1
Aug. 29, 1:30 PM	0.86/NE	ND	Overcast	Warm	Fresh breeze/SW	1	-3	3
Aug. 29, 3:00 PM	2.14/NE	ND	Dry/clear	Warm	Gentle breeze/SE	1	-2	3
Aug. 30, 7:00 AM	2.76/NE	1.5 hours	Dry/clear	Warm	Fresh breeze/SSW	2	-2	1
Aug. 30, Evening	0.86/NE	ND	Dry/clear	Warm	Light air/SW	1	-3	3
Sept. 1, 6:00 PM	2.11/NE	ND	Overcast	Warm	Gentle breeze/NW	1	-2	2
Sept. 1, 8:00 AM	2.76/NE	ND	Rain	Warm	Gentle breeze/S	3	-3	3
Sept. 2, 6:00 PM	2.11/NE	ND	Overcast	Cool	Light breeze/SW	1	-3	2
Sept. 2, 7:00 AM	2.76/NE	1 hour	Dry/clear	Warm	Moderate breeze/S/SW	1	-1	2

Date/Time	Distance (km) and Direction [1]	Duration of Odour	Weather Conditions	Temperature	Wind Strength/ Direction [2]	Odour Characteristics		
						Type	Intensity	Persistence
Sept. 3, 6:00 PM	3.26/SE	ND	Dry/clear	Warm	Light breeze/N	1	-1	1
Sept. 3, 4:00 PM	0.86/NE	1 hour	Dry/clear	Cool	Light breeze/SW	1	-3	3
Sept. 5	2.11/NE	ND	Dry/clear	Warm	Light breeze	5	-2	2
Sept. 5, 7:00 AM	2.76/NE	ND	Dry/clear	Warm	Light air/SW/W	3	-2	1
Sept. 5	0.86/NE	ND	ND	ND	ND	ND	ND	ND
Sept. 6, 8:00 AM	2.76/NE	4 hours	Dry/clear	Warm	Calm/SW/W	3	-1	2
Sept. 7, 6:30 PM	2.11/NE	ND	Dry/clear	Warm	Calm/SW	5	-2	2
Sept. 8, 5:00 PM	2.76/NE	2 hours	Overcast	Warm	Light air/SW	3	-1	1
Sept. 8, 6:15 PM	0.86/NE	Evening	ND	Cool	Moderate breeze/S	1	-3	3
Sept. 8, 3:00 PM	0.86/NE	1.5 hours	Dry/clear	Warm	Calm/Light air/S	1	-2	3
Sept. 9, 6:30 PM	2.11/NE	ND	Overcast	Warm	Light breeze/SW	5	-2	2
Sept. 10, 4:00 PM	2.14/S	ND	Dry/clear	Warm	Light breeze/E	1	-1	3
Sept. 10 / ND	1.48/S	All day	Overcast	Warm	Calm/SW	4/5 [3]	-3	3
Sept. 11, 7:00 AM	2.76/NE	2 hours	Overcast/rain	Cool	Gentle breeze/W	ND	ND	ND

NOTES:
[1] from Viking Fur farm location (centroid)
[2] Respondents were asked to identify the direction that the wind was blowing from. Wind directions recorded by respondents may not reflect actual conditions.
[3] Multiple odour types were identified by the respondent. For the statistical analysis, each odour type was considered a unique event.
ND = no data provided; maintained in record for completeness but not included in statistical analysis when one of more critical data points was missing
**Given the volume of survey information, only odour events have been reported in this table. The surveys data also accounted for periods where no odours were detected within the community.